

The Blast Furnace and Steel Plant

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CONTENTS

	Page
EDITORIAL: THE WORLD'S LARGEST BLAST FURNACE.....	189
A HEAT-BALANCE OPEN-HEARTH — By F. J. Crolius.....	190
REPAIRS TO ROLLING MILL ENGINE SHAFT—By E. R. Norris.....	193
SHEET AND TIN PLATE:	
PICKLING OF STEEL — By C. A. Edwards, Part II.....	195
DESIGN FOR ANNEALING BOX — By W. M. Crother.....	198
SHEET STEEL EXECUTIVES TO MEET.....	199
CALCULATION OF THE COMBUSTION OF COKE OVEN GAS — By F. M. Washburn.....	200
THE SAFETY CRUSADE:	
THE GROWTH OF AN IDEA — By E. Branson.....	203
WILL CHIPPERS WEAR GOGGLES?—By W. H. Steele.....	204
CURRENT REVIEW:	
IRON AND STEEL PRODUCTION.....	205
CURRENT LITERATURE ON FERROUS METALLURGY — By E. H. McClelland.....	207
TURBINE BLADE MANUFACTURE.....	208
MEETING OF REFRACTORIES INSTITUTE.....	214
THE POWER PLANT:	
FLEXIBILITY IN POWER PLANT EQUIPMENT — By N. L. Davis.....	215
EXPANSION STEAM BENDS — By P. M. Gallo.....	218
WITH THE EQUIPMENT MANUFACTURERS.....	222
TRADE PUBLICATIONS AND NOTES.....	225
OPEN-HEARTH PAGE.....	226
BY-PRODUCT NOTES.....	227
NEWS OF THE PLANTS.....	228

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The Blast Furnace *and* Steel Plant

Vol. XIII

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No. 5

The World's Largest Blast Furnace

We often speak casually of the blowing in of a blast-furnace. Few realize just what that means.

When No. 5 at South Works was blown in by Illinois Steel the facts were stated. The dimensions involved are: Hearth diam., 21 feet 6 inches; bosh diam., 24 feet 3 inches; height, 92 feet; working volume, 28,690 cubic feet.

504,500 9-inch brick or equivalents were used, requiring 120 tons of fire-clay to set. The steel plate shell weighs 300 tons.

To drive the moisture from the brick work required the burning of 3,000 cubic feet of gas per minute for 1,000 hours. This is the equivalent of 712 tons of coal. 327,000 pounds of coke were used; 3 cords of wood, 8,000 pounds of slag, and 1,600 pounds of limestone.

The furnace was blown up on 10,000 cubic feet of wind per minute, held for 6 hours, then every hour thereafter the wind increased 1,000 cubic feet per minute, until 43,600 cubic feet per minute had been reached.

Such is the customary start of a million-ton campaign.

A Heat-Balance Open-Hearth

Automatic Control of Furnace Pressure is Accomplished by
Novel Application of Fan Units

By F. J. CROLIUS*

IN the January issue of The Blast Furnace and Steel Plant, beginning on page 42, there will be found a resume of the outstanding features of open hearth development during 1924. Quoting from the January issue: "It would seem now to be clearly established that the forced-draft furnace has come to stay because it is longer lived, costs less for repairs, makes more steel and uses less fuel than natural draft furnaces.

* * *

Natural draft practice in boiler installations used to be strongly advocated by boiler builders. They claimed there was no gain in efficiency by the use of forced draft and (in very extreme and prejudiced minds) they also claimed that they could show as great capacity under natural draft as could be obtained with forced draft.

* * * *

"The fundamental reason why the old-time natural draft advocates were wrong is because gases behave differently when they are pushed, from the way they behave when they are pulled, and also because combustion resulting from forced draft can be more completely controlled as to space, time and intensity than when it results from natural draft.

* * * *

"A weak spot in each of these furnaces was the water-cooled valve system. The valves gave a great deal of trouble. The deposit of scale and mud from the water used, the interruptions in actual water supply, the warping of valves and seats and the sticking

*Editor Blast Furnace and Steel Plant.

of valve operating mechanism all combined to make the operation difficult and uncertain.

* * *

"The successful operation of these furnaces also depends on the complete withdrawal of the valves from the flues of the outgoing end. When the valves did not function properly the furnaces slowed down or there was very troublesome backlash on the furnace doors.

* * * *

"The more air introduced through the burner the shorter the flame. The reduction in air supply will place the flame at any point in the bath at the will of the operator. This again is very similar to the behavior of gas burners under boilers.

* * * *

"*** We are tempted to prophesy for 1925 a great advance in open hearth practice. *** A well conditioned flexible controlled furnace will help the metallurgist as much as the operator."

* * *

Just what a balanced furnace means to the open hearth operator has been forcibly illustrated by a number of years' success with a 65-ton furnace producing steel under the average conditions which prevail in one of the important plants in the Chicago district.

With furnace pressure control secured by the installation of standard automatic pressure control equipment working on the blast to the gas producers, a constant internal balance was maintained. Charts showing the difference in tonnage evidence a truly

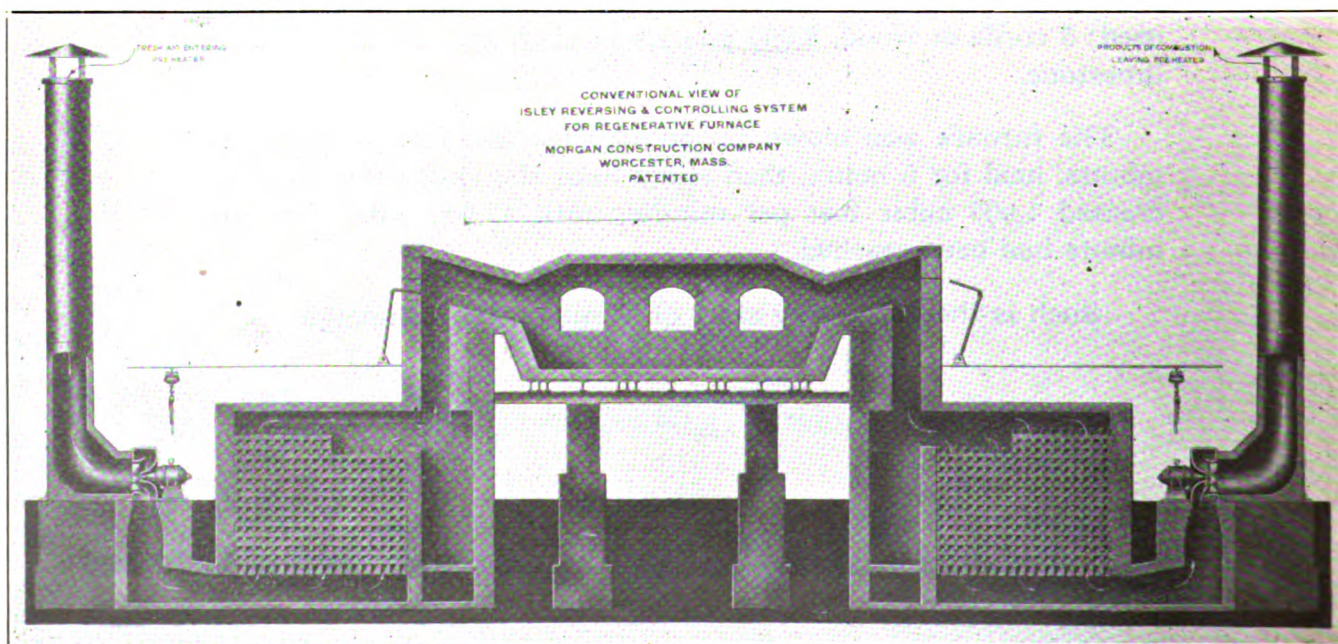


FIG. 1.—A side elevation of an open-hearth furnace equipped to operate in balance, and without the usual stack and valves.

remarkable increase, not confined to a few heats, but consistently through the year.

* * *

What has been achieved in steam practice where efficiencies are now approaching the maximum practically possible, bids fair to be obtained in open hearth operation.

that the gases leave the stack at about 700 deg. F. (See Fig. 2.)

The speed of the two fans can be controlled instantly and the required relation between them established at the will of the operator. The slight pressure maintained in the incoming checkers prevents air leaks.

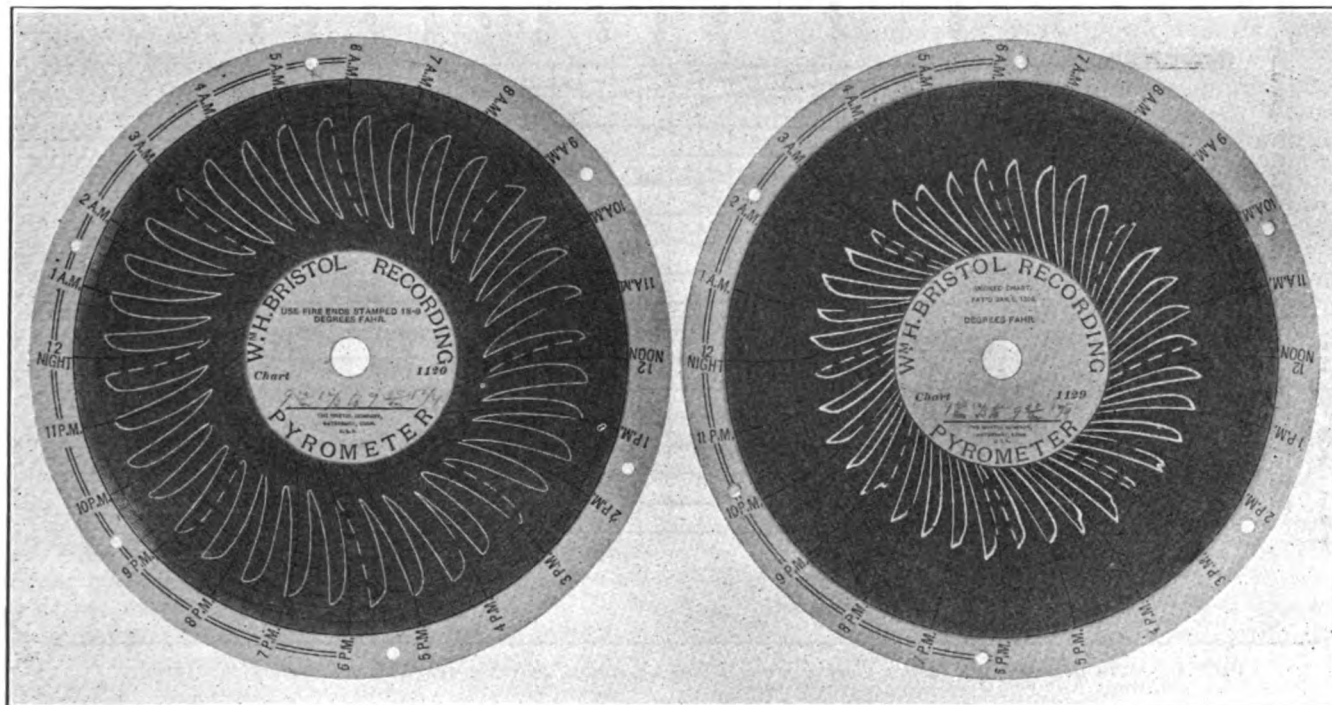


FIG. 2.—These two figures show the relative temperature difference, or heat gain when the Isley system is in operation. Chart on the left shows temperatures leaving the outgoing checker and entering exhaust fan. Chart at the right shows exit temperatures from recuperator tube.

It has remained for a combustion engineer to make a practical demonstration of definite and flexible control of the incoming and outgoing gases in an open hearth furnace. This has been accomplished by the use of two absolutely similar fans capable of acting alternately as blower of incoming air and exhauster of outgoing gas.

The furnace thus handled becomes as nearly as is practically possible a balanced furnace, and under complete operative control.

Mr. Isley of the Morgan Construction Company of Worcester, Mass., has now taken the logical step forward by designing an open hearth furnace controlled by the use of two fans as mentioned above and operating with two short stacks which serve alternately as inlets for atmospheric air and as discharge for the gases of combustion. This arrangement takes the place of the single lofty stack and reversing valve hitherto necessary.

Fig. 1 gives a clear idea of the extreme simplicity of the design. Air is preheated from atmospheric temperature to about 550 deg. F. in the inlet stack. It is then drawn through the blower, passed through the incoming checkers and supplied to the furnace through simple flue arrangements as shown. When the gases have been burned and have passed the outgoing checkers the temperature is reduced sufficiently so that the exhauster can handle the gas without trouble and the flow from the exhauster through the exhaust stack still further reduces the temperature so

The reversal of the furnace is almost instantaneous, occupying but a few seconds, and nearly two hours are saved in each 24-hour period due to quicker reversals.

A furnace may, of course, be centered by using both fans as exhausters. It may be kept hot with stored heat. It may be cooled off rapidly for repairs.

The first acid open hearth unit in operation has been in service in a large steel plant in New England for nearly nine months. Two campaigns on the furnace have been run, the present campaign recently ending after tapping 351 heats. The actual shut-downs during this campaign are of interest:

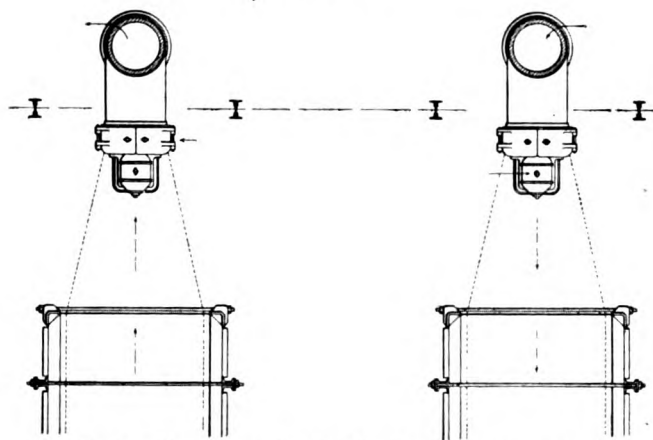


FIG. 3.—Plan view of the Isley furnace arrangement.

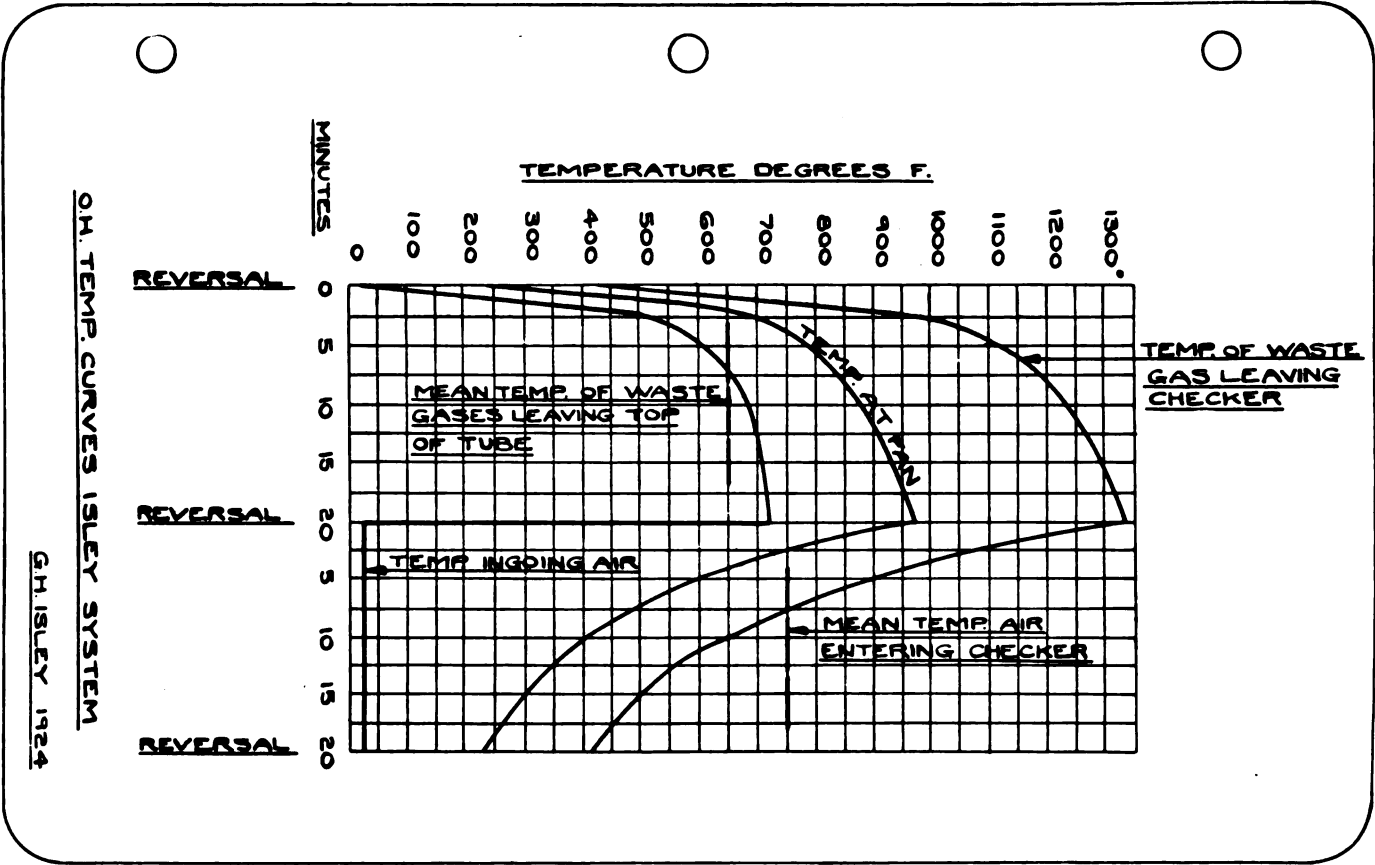


FIG. 4. — An assembly of curves plotted from actual operation showing the heat-balance of the furnace.

Hours	Minutes	
15	55	Repairing arch and jambs.
24		Cold furnace.
12		Explosion from foreign material in charge.
16		Repairing roof.
32	30	Christmas holidays.
	25	Joint in door.
3		Back wall patch.
24	5	Thanksgiving holiday.

An average of the daily log showing the averages of 16 weeks during present run appears as follows:

Number of heats per week—	
High	20.
Low	16.
Average	17.9

Time of heats—		Hrs.	Min.
In bottom			40
Charging	2		03
Melting	5		26
Testing	1		22
Time of heat (cold metal)	7		28
Time of heat (records)	5		45

Oil fired per ton of steel, gals.....	45.1
Total tons steel per week, former average	355
Total tons steel per week, present average	514
Record heat of 25.2 tons in 5:45 hours on 33.8 gallons of oil.	

The furnace is taking a charge over 25 per cent greater than its rated capacity.

The mechanism of the fan installation has given no trouble whatever. The quality of steel has shown no deterioration in spite of the large gain in capacity.

The performance of this furnace is being closely watched and further information will be furnished as available.

There is a saying that seven years are required to have a sound and practical idea become acceptable to the general public; when this happens the moment is termed psychological.

The seven year period in metallurgical combustion seems about to terminate. An enormous amount of observation and experiment has been carried through. Many methods and devices have been employed, and invariably some degree of success has attended the effort. Judged by these most recent results, the "open-hearth mind" has become a convert to progressiveness, and that being taken for granted, the result will follow. What is most needed now is that the metallurgical combustion problem, as a problem, be placed in the hands of a Dr. Kreisenger with carte blanche to put it down on paper, and answer the question for all.

The Madison Iron Works, Inc., 449 East 120th Street, New York, has completed plans and will soon proceed with the erection of a new two-story plant for general iron and steel working at Radel Avenue and Tiffany Street, estimated to cost close to \$60,000, with equipment, for which arrangements will be consummated at an early date. George A. Bagge & Sons, 299 Madison Avenue, are architects.

The La Grange Iron Works, Inc., La Grange, Ga., has preliminary plans under advisement for a new one-story addition to its plant for considerable increase in output. It is expected to begin work at an early date. The expansion is reported to cost in excess of \$50,000, including equipment. R. J. Higginbotham is president, in charge.

Repairs to Rolling Mill Engine Shaft

The Detailed Story of a Major Welding Operation Which Saved
Many Days of Mill Lost Time

By E. R. NORRIS*

THE 22 in. skelp mill of the Wheeling Steel Corporation at Steubenville, O., has a four stand continuous roughing mill driven by a 40 in. by 60 in. single cylinder side crank engine. The shaft of this engine is of unusual length, as it is extended into the gear drive housings, and is carried in three bearings, one of

The author of this article was formerly Master Mechanic of this plant. His many years experience in the vital problem of "getting back into service" large rolling mill units, every lost time hour of which is exceedingly costly, have given him an unusual perspective. The article is unique in that each detail is elaborated and the time and costs involved are actual not theoretical.

which is in the engine frames and the other two are in the gear housings. Next to the main bearing in the engine frame the shaft carried a 50-ton rope wheel 20 ft. 6 in. in diameter which drives the first and second stands of the mill. Beyond the middle bearing there is a double helical gear 20 in. face by 68½ in. diameter, which drives the third stand. At the extreme end, beyond the third bearing the shaft drives the fourth stand of the mill through the usual crab construction.

This shaft was broken at 7 p. m. Wednesday, October 3, 1923. The break occurred in a 17½ in. diameter section between the second bearing and the helical gear. The immediate decision was to repair the shaft by means of a Thermit weld, but the method to be followed was a matter of study on account of the unusual conditions. The space between the bearing and gear, where the shaft broke, was only 25¼ in. wide. A weld at this point with the gear in place was not possible. To replace the gear after a weld was made would require the removal of the shaft from the engine frame and the gear housings. This method would involve the possibility of the gear and third journal becoming eccentric to the main and second journals. To abandon the welding idea and provide a new shaft would involve securing a 40,000 lb. forging and machining this to fit the crank disc, rope wheel and gear, and necessitate the dismantling and reassembling of the sectional rope wheel weighing about 50 tons. This work would require four to six weeks time. However, by 3 a. m. Thursday a method of repair was found which would insure mechanical strength and a running gear and journal. This method provided for a flange welded to the large part of the shaft which carried the rope wheel and the employment of the gear hub as a companion flange to be bolted to the welded flange. The gear was sent to the machine shop to have the rough hub faced and to be drilled for 12 bolts 2 in. diameter on 25½ in. bolt circle. A cross key-way 4 in. wide by ¾ in. deep was planed in the hub. A new shaft was fitted to the tight crab and to the gear, being allowed to extend ⅛ in. beyond the face of the gear hub. The

assembly was then put on the slotter and the key-way in the hub was continued across the end of the shaft.

While this work was in progress a slab was rolled on the blooming mill 31 in. wide by 6 in. thick. From this a disc was cut with a gas torch, and the disc was turned to 20 in. diameter by 5½ in. thick with a flange 30 in. diameter by 3 in. thick. Across the face of the disc a key-way 4 in. wide by ¾ in. deep was cut to correspond with the key-way in hub gear. The 30 in. diameter flange was drilled with 1¾ in. holes on 25½ in. bolt circle. The slab was delivered to the machine shop at 6 p. m. Thursday and the machine work on the disc was completed at 8 p. m. Friday.

In the meantime, the engine connecting rod and the middle journal bearings were removed and the shaft and rope wheel were elevated about two feet. The broken end of shaft was cut off on a line 5 in. from the end of the middle journal. This distance, 5 in., was provided to allow for the 2½ in. extension on the back of the flange and the 2½ in. needed for the Thermit weld.

The most difficult feature of the whole job was to set the flanged disc concentric and square with the engine shaft axis and hold it in position during the building of the wax pattern and the ramming of the mold.

The 22 in. middle journal was so badly worn that its surface could not be used for alignment. The disc was set parallel with the rim of the rope wheel and held in position by four narrow steel straps, spaced at 90 deg. intervals and acetylene welded to the shaft and to the disc. This work was completed and the wax pattern started at 2 a. m. Saturday.

At 2 p. m. Saturday the mold was completed and the heating was started. On account of the great difference between the heat absorbing capacity of the heavy shaft and the lighter disc, the heat was directed against the shaft end and the disc was allowed to heat by radiation from the shaft. The heating was terminated at 10:30 p. m. Saturday and the weld was made at 10:50. At 2 p. m. Sunday the mold was removed from the weld. Gates and risers were cut off and the collar of the weld was reduced with a gas cutting torch, so that at no point was it over ¾ in. higher than the journal.

The bottom shell of the middle bearing had a babbitt lining slightly over ¾ in. thick and this babbitt was removed for a space of 7 in. at one end to provide clearance for the collar of the weld. The shell was replaced in the housing and the shaft with the flanged disc welded to it was lowered into place at 10 p. m. Sunday.

During the preparations for the weld, an electric motor had been arranged to drive, through suitable gear reductions, four rope sheaves 24 in. in diameter. This motor drive was anchored about 60 ft. from the shaft and four transmission ropes were spliced around the four rope sheaves and the large rope wheel. This drive rotated the shaft at 4 rpm. which gave a journal speed of about 24 ft. per minute, suitable for good machine work.

A portable Morton draw cut shaper was set above the bearing housing and securely bolted down in such

*Steubenville, Ohio.

position that the tool could be used on the weld or on the face of flange with the single setting. The shaper motion was not employed as the machine was used only as a convenient tool holder having ample traverse in both directions. Machining the collar from the weld started at 4:30 a. m. Monday.

The flange was found to be only 1/16 in. out of true. This was faced and a recess turned 17½ in. diameter and 3/16 in. deep to accommodate the shaft which extended through the gear hub. This work was completed at 11 p. m. Monday.

The gear and short shaft were then put in place and the holes in the flanges were reamed to fit the 2 in. bolts and to coincide with the holes in the gear hub. This work was finished at noon Tuesday.

The reassembling of the engine, connecting to mill and replacing ropes on the rope wheels was completed and the mill started to roll steel at 10 p. m. Tuesday or 147 hours after the shaft was broken. The entire job including the services of the Metal and Thermit Company engineers who made the weld, all materials, labor and overhead was \$4,488.00. This cost is comparable with a probable cost of a new shaft at \$7,000 and an assembling and installation cost of \$6,000 or a total of \$13,000. This comparison, however, does not include the loss due to the mill being idle for several weeks to secure and install a new shaft, instead of the six days required by the repair.

This repair has now had over one year of service and the only attention required has been the occasional replacement of the bolts.

This repair involved Thermit welding, acetylene welding as an auxiliary, and machine work both in the shop and in the field. The major portion of the time, as indicated by the description, was consumed by the machine work preparatory and subsequent to the actual welding, but the key-stone of the job was the Thermit weld as the repair was made possible only by the use of the Thermit process.

Vanadium, a Chemical Curiosity Put to Use*

This silver-white metal appears to have derived its name from Vanads, a goddess of Norse mythology. But the tales of mythology are no more romantic than the narrative of the search for vanadium, when once its possibilities for usefulness began to be perceived. The story of vanadium is a history of geographical exploration, scientific research and technical development, sustained by human pluck and persistence through great difficulties and many discouragements to ultimate success. The world is enriched by the victories of business foresight co-operating with scientific talent.

The chemical element, vanadium, was discovered in 1801 by Del Rio, a mineralogist in Mexico, but practically for a century it remained in oblivion, being relegated to the specimen cabinets of mineralogical museums. It aroused the scientific curiosity of such eminent chemists as Wohler, Berzelius, and Sir Henry Roscoe, who studied its chemistry without finding any practical application for it in the arts. In 1900 Professor Arnold, who was connected with the University of Sheffield, England, pre-eminent center of the cutlery and tool-steel world, conceived the idea that this strange element might impart some beneficial

properties to tool-steel. He experimented on a small scale in his laboratory and found that the addition of vanadium had wonderfully increased the cutting qualities of his steel. As vanadium was not commonly found in minerals, and was considered a rare element costing much more even than gold, the knowledge of its useful properties in steel could not be readily commercialized.

It was left to the adventurous spirit and commercial vision, inborn of the American business man, to overcome these obstacles. Two brothers, J. J. and J. M. Flannery, of Pittsburgh, having heard of this strange metal element and its stranger influences in steel, and being born and raised in the cradle of the American steel industry, Pittsburgh, conceived the idea of obtaining financial aid from a few of their business friends, in order to make this element commercially available to the industry of their home town. They scoured all the world for possible sources of vanadium minerals. Finally, they succeeded in locating the richest and most unusual deposit of vanadium sulphide, a mineral known as patronite, in the Peruvian Andes, at an altitude of over 16,000 feet above sea-level.

This discovery of the only known deposit of vanadium ore, while a stupendous task in itself, was only the beginning of the difficulties which the small company, organized by the Flannerys, had to face. They had to convince the steel-makers at home that the use of vanadium had salutary effects. American steel-makers had not heard of vanadium before. After they had convinced the steel-makers, the Flannerys were confronted with the problem of reducing the vanadium to metal out of the ore. No one had done this commercially before. Undaunted, they turned again to the world and obtained the services of the best suited men for the task. With full belief in the success of their undertaking, they devoted all their available funds to building up from the bottom the metallurgy of vanadium, by scientific research, with the aid of these men.

For the very serviceable result, the world should thank the pioneering spirit of the Flannerys and their collaborators, for this result is one of the most potent metallurgical factors in the rapid progress of our industries, namely: "Vanadium Steel." Vanadium is an essential component of all high-speed tool steel, which fashions all our machines of peace and war, big or small, from monster guns to automobile engines. Again, the stresses developed by our present tendency to speed could not have been overcome without the use of vanadium. It is for this reason vanadium steel is used largely in the construction of automobiles, aeroplanes, and railroad equipment. It has thus contributed immeasurably to our comfort and safety and to our rapid industrial advance.

Where could we find a more romantic tale than that of the adventurous spirit and commercial foresight of a few business men who succeeded in discovering an isolated deposit of an unknown mineral at the top of the world, and in gathering together a coterie of scientific and technical talent to solve new metallurgical problems, thus founding a branch of metallurgical industry, which has fortunately proved of such immense value to our modern civilization?

Conveyed at first on the backs of Llamas and later by narrow-gauge railways and trucks, from the per-

(Continued on page 202.)

*Contributed by B. D. Saklatwalla, Ph.D., member American Institute of Mining and Metallurgical Engineers, Vice President Vanadium Corporation of America, Bridgeville, Pa.

SHEET AND TIN PLATE

Pickling of Steel*

A Practical Contribution to an Important Phase of Sheet Practice

By C. A. EDWARDS†
PART II.

THERE is every reason to suppose that the rate of hydrogen diffusion is not only governed by temperature itself, but also by the rate at which the hydrogen is generated upon the surface of the metal upon which the acid is acting. It was not possible, in this series of experiments, to make a reliable separation of these two variables, but a special attempt was made later with this object in view.

Series of Tests Using Normal Sulphuric Acid at Varying Temperatures.

TABLE IX — Temperature, 3 · 5° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
3	0	0.52
5	0	1.55
7	0	3.06
9	30	5.08

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 8 hours 12 minutes.

TABLE X — Temperature, 12° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
0	30	0.165
1	15	1.05
1	45	2.14
2	25	4.03
2	45	5.09

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 2 hours 24 minutes.

TABLE XI — Temperature, 25° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
0	45	1.32
1	0	2.42
1	15	3.68
1	30	5.14

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 19 minutes.

TABLE XII — Temperature, 50° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
0	15	1.58
0	20	2.75
0	25	4.19
0	30	5.65

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 24 minutes.

TABLE XIII — Temperature, 75° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
0	5	1.20
0	8	2.87
0	10	4.09
0	12	5.11

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 9.5 minutes.

TABLE XIV — Temperature, 100° C.

Duration of Test.		Volume of Hydrogen, at 0° C., Diffused C.c.
Hours.	Minutes.	
0	3	1.135
0	4	2.35
0	5	3.15
0	6	3.89
0	7	4.41

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 6.1 minutes.

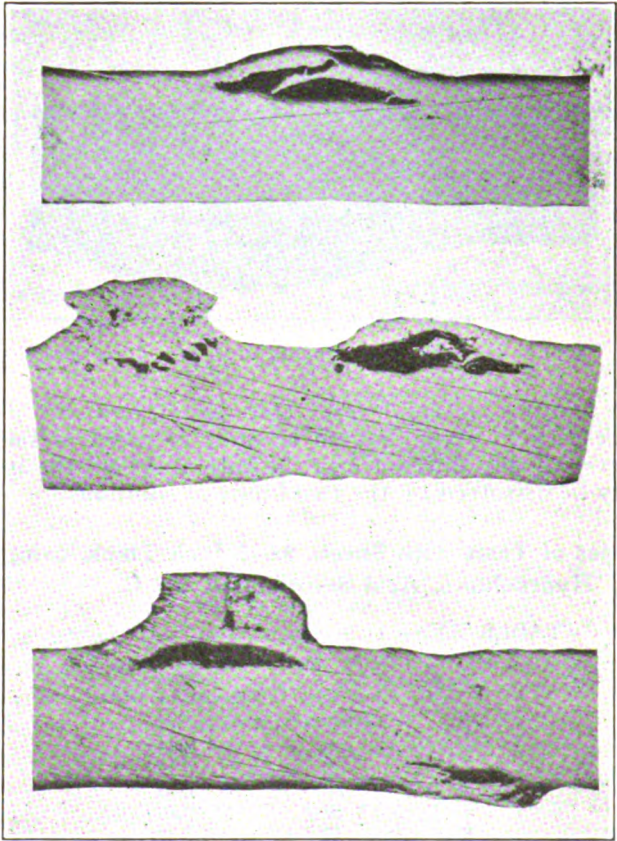


PLATE 1.—Photomicrographs showing unetched cross-sections of peppery blistered tin plates.

*British Iron and Steel Institute Paper.
†Swansea, England.

Experiments with Hydrochloric and Sulphuric Acids of Varying Strengths at 50° C.

The same kind of sheets were used for these series as for those previously described. The results obtained with hydrochloric acid solutions are given in Tables XV to XXII, and those with sulphuric acid solutions in Tables XXIII to XXX. For the purpose of comparison, the estimated times for the diffusion of 4 cubic centimetres of hydrogen for both series have been plotted on the same chart, not shown. The acidities for the hydrochloric acid solutions have been calculated to, and plotted in, terms of grammes H_2SO_4 per litre. Careful study of these curves allow the conclusion to be drawn that the rate of diffusion is considerably quicker when sulphuric acid solutions are used than when hydrochloric acid solutions of correspond-

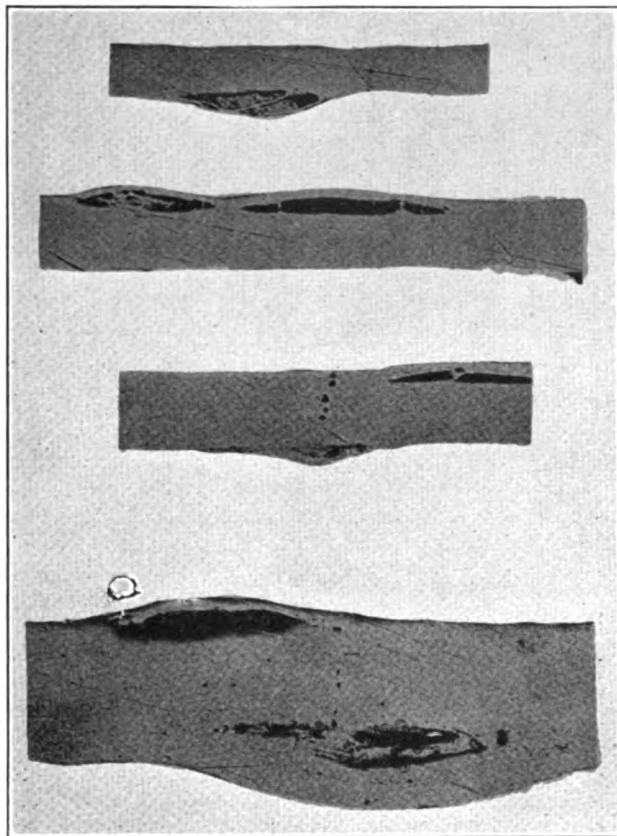


PLATE 2.—Additional exhibits of blistered tin plates.

ing acidities are employed. Here again, however, it is necessary to state that no account is taken in these curves of any difference in the rate at which the iron may be dissolved by the two kinds of solutions.

Series of Tests with Sheets 0.005 Inch Thick, using Hydrochloric Acid Solutions at 50° C.

TABLE XV — 1.94 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
1	0	0.046
2	0	0.17
3	30	0.46
4	50	0.76
8	40	2.40

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 11 hours 12 minutes.

TABLE XVI — 3.87 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
1	5	1.26
1	30	2.50
2	30	5.55

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 2 hours 6 minutes.

TABLE XVII — 9.32 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.203
1	0	1.09
1	30	2.67
1	45	3.76

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 47 minutes.

TABLE XVIII — 18.64 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.64
1	15	5.21

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 8 minutes.

TABLE XIX — 25.8 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.44
0	45	1.23
1	0	2.57
1	15	4.18
1	45	7.25
2	15	10.47

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 13 minutes.

TABLE XX — 36.5 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.60
0	45	1.73
1	0	3.21
1	15	6.80
1	30	8.74

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 4 minutes.

TABLE XXI — 97.1 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.48
0	45	1.28
1	0	2.69
1	15	4.79
1	30	7.27
1	45	10.00

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 1 hour 10 minutes.

TABLE XXII — 185.8 Grammes HCl per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	1.09
0	45	2.84
0	50	3.32

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 54 minutes.

Series of Tests with Sheets 0.005 Inch Thick, using Sulphuric Acid Solutions at 50° C.

TABLE XXIII — 4.88 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	30	0.90
0	45	2.58
0	55	3.70
1	0	4.25
1	10	5.38

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 57 minutes.

TABLE XXIV — 9.76 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	15	0.14
0	50	5.56

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 45 minutes.

TABLE XXV — 18.5 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	10	0.07
0	20	0.76
0	30	2.05
0	40	3.50
0	50	5.23
1	0	7.15

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 43 minutes.

TABLE XXVI — 37.0 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	10	0.20
0	26	3.05
0	31	4.22
0	37	5.54
0	45	7.25

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 30 minutes.

TABLE XXVII — 90.6 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	10	0.49
0	20	2.59
0	30	5.71
0	40	8.98

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 25 minutes.

TABLE XXVIII — 184.0 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	5	0.26
0	10	1.23
0	15	2.75
0	20	4.58
0	25	6.51

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 18.5 minutes.

TABLE XXIX — 282.0 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	5	0.28
0	10	1.52
0	15	3.80
0	20	6.46
0	25	9.27

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 15.5 minutes.

TABLE XXX — 381.0 Grammes H_2SO_4 per Litre.

Duration of Test.		Volume of Hydrogen Diffused, Calculated to 0° C.
Hours.	Minutes.	C.c.
0	5	0.85
0	10	2.97
0	15	5.80

Estimated time for the diffusion of 4 cubic centimetres of hydrogen, 12 minutes.

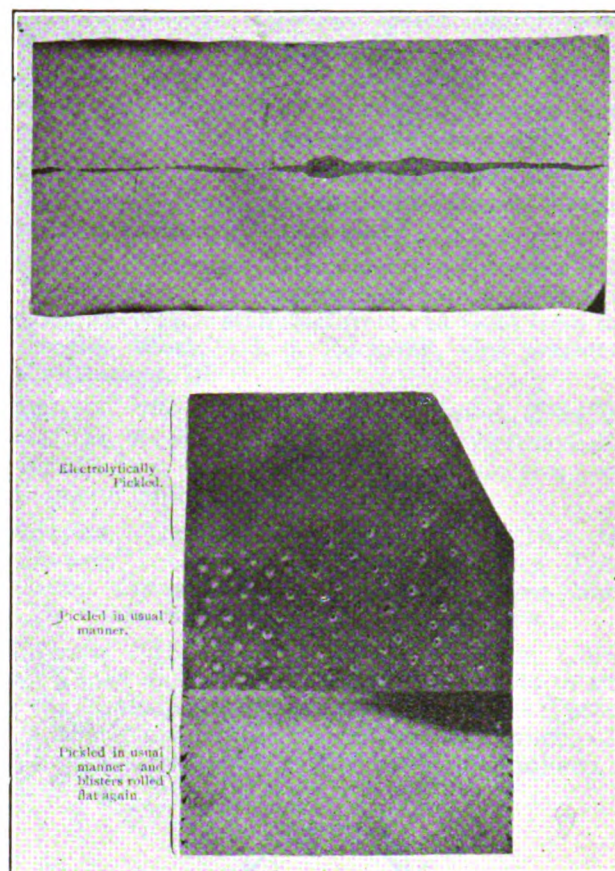


PLATE 3 (Upper).—Photomicrograph of oxide film between two sheets. (Lower)—Electrolytically pickled sheet shows no signs of blistering.

Normal Hydrochloric Acid at Temperatures Between 0° and 100° C. Sheets 0.005 Inch Thick.

It is interesting to note that on comparing the results of this series of experiments with those obtained with normal sulphuric acid at corresponding temperatures there is a similar difference in the rate of diffusion as was observed for the two series of experiments that were made at 50° C, when using HCl and H_2SO_4 solutions of varying acidities. Thus it would seem that the rate at which hydrogen will diffuse through steel is greater when the gas is generated, on the surface of the metal, from sulphuric acid solutions than from solutions of hydrochloric acid. This rather interesting observation holds good for all temperatures and acidities. This seems to be a remarkable fact, for it is scarcely in the direction that would have been anticipated. At first it was thought that it might be due to the presence of traces of free chlorine in the hydrochloric acid solutions acting as an oxidizing agent on some of the hydrogen.

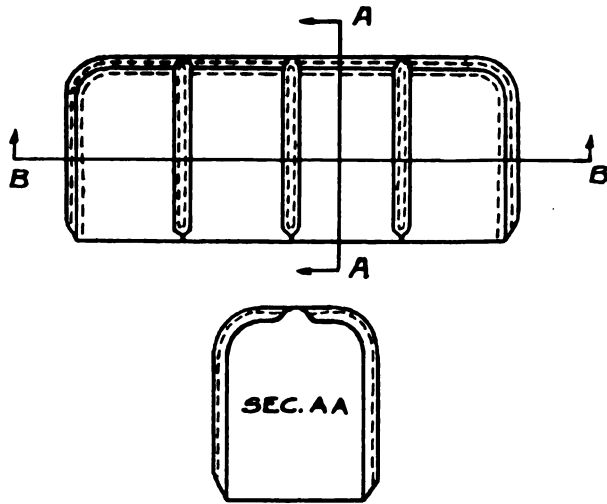


FIG. 1



FIG. 2



FIG. 3

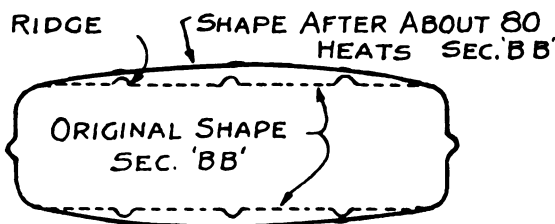


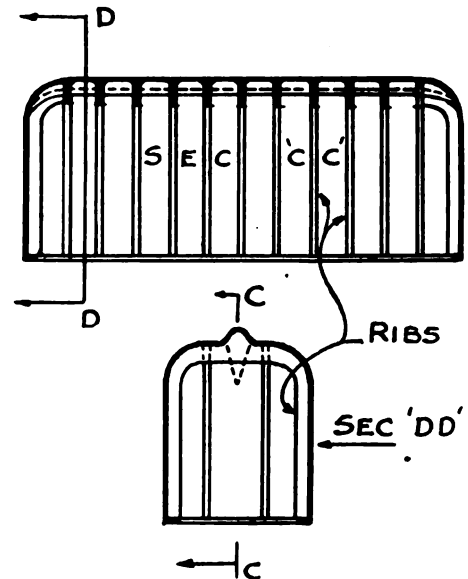
FIG. 4

Design for Annealing Box

By Walter M. Crowther*

The general design of annealing boxes seems to be very much the same; this may have resulted from the

*Middletown, Ohio.



PROPOSED BOX. FIG. 5

fact that the design of such a box seems so simple that the problem is seldom turned over to an engineer or a designer for analysis. The foundryman decides to make the box a certain shape; a detailer is assigned to follow his instructions; the design is drawn; the patterns made, and the casting poured; all this is done with the hope that the box will stand up for a few more heats than the last similar one.

From the engineering standpoint it is entirely possible to develop a better annealing box.

Fig. 1 shows the general design of box in service in a typical large plant.

The explanation of the side that bulges in the center and kicks in at the bottom is that the bottom flanges are not securely held; the bulging at the center supplies the force required to curl under the sides.

This box is bellied out like a colicky cow after about 80 heats, (see Fig. 2), or it bellies out and the sides kick way in under at the bottom, (see Fig. 3).

The explanation for this is that the roof was so heavy that it bulged it out. But, also notice that as it bellies out that the ridges disappear, (Fig. 4). Also notice that both at the top and bottom there is no excess metal to allow this lengthening process to take place there also. This leads one to believe that the ridges are the cause of the distorted shapes.

In the present type annealing box there is less inside surface than outside surface, which cuts down its possibilities as a heat transfer agent from the outside to the inside.

It is suggested that Fig. 5 would be a much better box than those that are in general use. With the many ribs on the inside there would be more radiating surface on the inside. Because of this greater radiating surface on the inside, the temperature drop through the box would be greater and the box would do its work faster. This would cut down the time of annealing and make more heats possible with the same box.

In this design the box would also be stronger against sagging and curling under. The ribs, not being tied, except at the bottom flange, put no more stress in the box than the present design.

This type of box could also be cast without the baked core.

Sheet Steel Executives to Meet

The Third Annual Gathering of this Important Body to be Held
at White Sulphur Springs May 4, 5, 6 and 7

THE Greenbrier will entertain the membership of the National Association of Sheet and Tin Plate Manufacturers during the week beginning May 4. This is one of the most colorful gatherings held annually by members of the industry.

A varied program is always offered; this year considerable emphasis is to be laid upon the details and results which have accrued from two major programs recently inaugurated by the association. Mr. Carroll will dwell upon the simplification program, initiated under his immediate supervision, and Mr. Springer and Mr. Rockwell, who have carried forward the Trade Expansion plan, will indicate the results to date and projected.

The complete business program appears as follows:

Address, "The Sheet Steel Industry." W. S. Horner, president, National Association Sheet and Tin Plate Manufacturers, Pittsburgh, Pa.

Address, "Is the Industrial Manager the Victim of Price Movement or Can He Control Them?" Magnus W. Alexander, president, National Industrial Conference Board, New York, N. Y.

Address, T. D. McCloskey, General Counsel, National Association Sheet and Tin Plate Manufacturers, Pittsburgh, Pa.

Address, "Executives Responsibility to Stockholders and the Public." Severn P. Ker, president, Sharon Steel Hoop Company, Sharon, Pa.

Address, "Distribution Problems, the Value and Effect of Educational Work Within the Sheet Steel Industry." Frank A. Weidman, special representative, Inland Steel Company, Chicago, Ill.

Address, "Whither Are We Drifting?" Murray Springer, general director, Operating Branch, Sheet Steel Trade Extension Committee, Chicago, Ill.

Address, "Wasters and Seconds, Their Effect on the Industry." M. C. Summers, president, Thomas Sheet Steel Company, Niles, Ohio.

Address, "Member Companies Co-operation with the Trade Extension Program—A Study of Definite Methods by Which Manufacturers can Gain from and Aid in this Work." J. J. Rockwell, vice president, Crosby-Chicago, Ill.

Address, "Sheet Steel Simplification—A Brief Review of the Work, and What has been Accomplished During the Past Year." Walter C. Carroll, vice president, Inland Steel Company, Chicago, Ill.

Address, "Trade Extension Retrospective and Perspective." Clayton Patterson, secretary Trade Extension Committee, National Association Sheet and Tin Plate Manufacturers, Pittsburgh, Pa.

Address, "The Radical Situation in the United States Today and What the Executive can do to Prevent the Spreading of Radical Ideas." Jacob Spolansky, formerly chief Military Intelligence Branch, Chicago Sessions commence at 9:30 A. M. and adjourn at 12:30 P. M.

British Iron and Steel Institute

The annual dinner of the British Iron and Steel Institute will be held at the Hotel Cecil, Strand, London, W. C., on Thursday, May 7th, 1925, at 7.0 for 7:30 p. m., under the presidency of Sir Frederick Mills, Bart.

List of papers offered for the 1925 meeting:

L. Aitchison and L. W. Johnson, "The Effect of Grain upon the Fatigue Strength of Steels."

H. Von Eckermann, "A Method for Reducing the Percentage of Phosphorus in Swedish Iron by Diminishing the Phosphorus in the Charcoal."

B. D. Enlund, "On the Structure of Quenched Carbon Steels."

G. Watson Gray and C. D. Garbutt, "Estimation of Phosphorus in the Presence of Vanadium."

R. H. Greaves and J. A. Jones, "Temper-brittleness of Steel; Susceptibility to Temper-brittleness in Relation to Chemical Composition."

Mr. W. T. Griffiths, "Note on Nitrogen as a Possible Factor in Temper-brittleness."

Mr. T. W. Hand, "Progress in British Rolling-mill Practice."

A. Hultgren, "'Flakes' or 'Hair Cracks' in Chromium Steel, with a Discussion on 'Shattered Zones' and 'Transverse Fissures' in Rails."

D. H. Ingal and H. Field, "'Peeling' in White Heart Malleable."

A. G. Lobley and C. L. Betts, "The Influence of Gases at High Temperatures upon Iron, with Special Reference to the Formation of Blowholes."

R. L. Smith and G. E. Sandland, "Some Notes on the use of a Diamond Pyramid for Hardness Testing."

T. Henry Turner and J. D. Jevons, "The Detection of Strain in Mild Steels."

J. D. Jevons, "Strain Detection in Mild Steel by Special Etching."

J. H. Whiteley, "Observations on Martensite and Troostite."

Calculations of the Combustion of Coke Oven Gas

A Valuable Method of Determining the Constituent Values in Any Combustible Gas

By FREDERICK M. WASHBURN*

THE main combustible constituents of coke-oven gas are hydrogen, methane, carbon monoxide, and the compounds classed as "illuminants." The determination of the percentage of "illuminants" is commonly made by noting the absorption in fuming sulphuric acid, and the compounds so absorbed are ethylene, benzene and its homologues, and possibly a very small amount of higher hydrocarbons of the ethylene series. For the calculations given, the "illuminants" are treated as if composed of ethylene only, as the error introduced by this assumption is small, providing the gas is thoroughly scrubbed so that the benzene content is low. Furthermore, a separate determination of each of these constituents of the "illuminants" is seldom made in works practice, so the exact composition of the "illuminants" is rarely available.

Any ethane or higher hydrocarbon of the methane series present in the gas is ordinarily not determined, but is reported as methane. The error introduced in the calculation of combustion products, assuming the figure ordinarily reported as methane to consist entirely of methane is very small, since in an analysis the methane is calculated from the amount of carbon dioxide it produces upon combustion.

The composition of air is approximately 21 per cent oxygen and 79 per cent nitrogen. When a combustible gas is mixed with air and burned, the oxygen of the air unites with the carbon present in the various compounds existing in the gas to form carbon dioxide or carbon monoxide, and unites with the hydrogen present to form water. The nitrogen present in the air remains unchanged, therefore the flue gases will be composed of a mixture of carbon dioxide, carbon monoxide, water vapor and nitrogen. The combustion of the various constituents of the gas takes place in accordance with the following reactions:

1. Illuminants (C_2H_4) $C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$.
2. Carbon monoxide (CO) $2CO + O_2 = 2CO_2$.
3. Hydrogen (H_2) $2H_2 + O_2 = 2H_2O$.
4. Methane (CH_4) $CH_4 + 2O_2 = CO_2 + 2H_2O$.

Taking the equation for the combustion of methane for an example, this means that one volume of methane unites with two volumes of oxygen to form one volume of carbon dioxide and two volumes of water vapor. From the above reactions, and the figures given on the composition of air, the following table may be derived:

*International Harvester Co., South Chicago, Ill.

TABLE I.

Volumes of gases produced by the combustion of one volume of the various constituents of oven gas, also volumes of oxygen and air required for combustion.

Constituent of Gas	CO ₂	H ₂ O	N ₂	O ₂ Req'd.	Air Req'd.
CO ₂	1	0	0	0	0
Illuminants					
Calc. as C ₂ H ₄	2	2	11.29	3	14.29
O ₂	0	0	0	-1	-4.76
CO	1	0	1.88	0.5	2.38
H ₂	0	1	1.88	0.5	2.38
CH ₄	1	2	7.52	2	9.52
N ₂	0	0	1	0	0

To use the above table, multiply the percentage of each constituent present in the gas by the factors for that constituent given under the various headings, and substitute the figures obtained for those given in the table. The sum of the figures in each vertical column gives the number of volumes of that particular gas produced from or required by the combustion of 100 volumes of gas.

For example, assume the composition of a coke oven gas to be as follows:

CO ₂	1.8%
Ill.*	4.8
O ₂	0.1
CO	6.9
H ₂	50.8
CH ₄	33.6
N ₂	2.0

Using these figures on the amounts present per 100 volumes of gas, or in other words, the percentage of the various constituents, and substituting in Table I, the following table may be obtained for this particular gas:

TABLE II.

Constituents	Vols. in 100 Vols. Gas	CO ₂	H ₂ O	N ₂	O ₂ Required	Air Required
CO ₂	1.8	1.8	...	...	...	...
Illuminants	4.8	9.6	9.6	54.19	14.40	68.59
O ₂	0.1	...	...	...	-0.10	-0.48
CO	6.9	6.9	...	12.98	3.45	16.43
H ₂	50.8	...	50.8	95.55	25.40	120.95
CH ₄	33.6	33.6	67.2	252.67	67.20	319.87
N ₂	2.0	...	...	2.00	...	...
Total	100.00	51.9	127.6	417.39	110.35	525.36

The total volume of flue gas produced by the combustion of 100 volumes of the given coke oven gas is equal to the sum of the volumes of CO₂, H₂O and N₂ produced, or

51.9 volumes of CO₂
127.6 volumes of H₂O
417.39 volumes of N₂

596.89 volumes of flue gas (above 212

deg. F.).

In case the water is condensed out, as happens when an analysis is made or when the gas is measured at a temperature below 212 deg. F., the volume of the flue gas produced is given by the sums of the volumes of CO_2 and N_2 produced, or

$$\begin{array}{r} 51.9 \text{ volumes of } \text{CO}_2 \\ 417.39 \text{ volumes of } \text{N}_2 \\ \hline \end{array}$$

469.29 volumes of flue gas (below 212 deg. F.).

The theoretical percentage of CO_2 in the flue gas (below 212 deg. F.) is then given by the following expression:

$$\frac{\text{Volumes } \text{CO}_2 \times 100}{\text{Volumes of flue gas produced}}$$

$$\text{or } \frac{51.9 \times 100}{469.29} = 11.06\%$$

This figure of 11.06 per cent represents the theoretical percentage of CO_2 in the flue gas, or in other words, the percentage of CO_2 which would be produced providing that just enough air for complete combustion was present, and that complete combustion took place. These ideal conditions are never realized in practice for several reasons. First, under working conditions it would be impossible to keep exactly the theoretical amount of air present and there would be times when an insufficient amount would be present, leading to the formation of carbon monoxide. Second, even if the theoretical amount of air was present at all times, there would be some carbon monoxide formed due to incomplete mixing of the gas, and slow speed of combustion. Third, the heat loss due to the formation of a small amount of carbon monoxide is greater than that due to the presence in the flue gas of a small amount of excess air. For the above reasons, it is customary to carry a small amount of excess air.

The "percentage of excess air" is a term frequently used, and which possibly requires some explanation. It may be defined as the ratio, expressed in per cent, of the volume of air present over that theoretically required for complete combustion, to the theoretical volume required for complete combustion. For example, 50 per cent excess air would mean that for every 100 volumes of air required for theoretical combustion, there were 150 volumes added. The theoretical volume of air required to burn any volume of gas may be calculated from the analysis as has been done in Table II for one particular coke oven gas. The percentage of oxygen in the flue gas gives the means of calculating the volume of excess air present, so that knowing the analysis of the gas, and the analysis of the flue gas produced, the percentage of excess air may be calculated.

Calculation of Percentage of Excess Air.

Let $a = \% \text{O}_2$ in flue gas.

Then $a \times \frac{100}{21} = \text{corresponding per cent of air.}$

Let $X = \text{volumes of excess air in flue gas produced by combustion of 100 volumes of gas.}$

Let $b = \text{volumes of flue gas (below 212 deg. F.) produced by theoretical combustion of 100 volumes of gas.}$

Let $c = \text{volumes of air required for combustion of 100 volumes of gas.}$

The total volumes of flue gas produced by the combustion of 100 volumes of gas is the sum of the theoretical volumes of flue gas produced and the volumes of excess air present, or $b + X$, and the percentage of X in the mixture is given by the expression

$$\frac{100X}{b + X}$$

This expression represents the percentage of air in the flue gas, and since we already have an expression, $a \times \frac{100}{21}$, which represents the same thing, the

following equation, containing only one unknown quantity, X , may be set up:

$$\frac{100X}{b + X} = a \times \frac{100}{21} = 4.76a \quad (1)$$

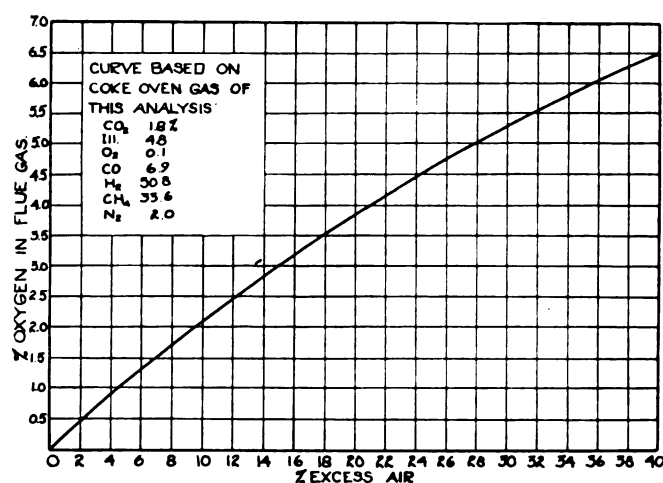


FIG. 1. RELATION BETWEEN EXCESS AIR AND OXYGEN IN FLUE GAS

Solving for X :

$$100X = 4.76ab + 4.76aX$$

$$100X - 4.76aX = 4.76ab$$

$$X(100 - 4.76a) = 4.76ab$$

$$X = \frac{4.76ab}{100 - 4.76a} \quad (2)$$

The percentage of excess air is then given by the following expression:

$$\frac{100X}{c} = \% \text{ excess air} \quad (3)$$

To illustrate, assume 2.5 per cent oxygen to the present in the flue gas, and taking values from Table II, that 469.3 volumes of flue gas (below 212 deg. F.) are produced by burning 100 volumes of gas, and that 525.4 volumes of air are required for perfect combustion of 100 volumes of gas.

$$\begin{array}{l} \text{Then } a = 2.5 \\ b = 469.3 \\ c = 525.4 \end{array}$$

Substituting in equation (2)

$$X = \frac{(4.76 \times 2.5) 469.3}{100 - (4.76 \times 2.5)} = 63.40$$

Substituting this value in equation (3)

$$\frac{63.40 \times 100}{525.4} = 12.1\% \text{ excess air.}$$

Assuming different percentages of oxygen to be present in flue gas, a series of values may be worked out for any gas, and the percentage of oxygen plotted against the percentage of excess air, giving a ready means for obtaining the percentage of excess air from a flue gas analysis. This has been done in Fig. 1 for the coke oven gas previously mentioned.

Calculation of Relation Between CO₂ in Flue Gas and Excess Air.

The relation between the percentage of CO₂ in the flue gas and the percentage of excess air may best be calculated by an indirect means, as follows:

Let c = volumes of air required for combustion of 100 volumes of gas.

d = per cent of excess air.

e = volumes of N₂ produced by combustion of 100 volumes of gas.

f = volumes of CO₂ produced by combustion of 100 volumes of gas.

Then $\frac{cd}{100}$ = volumes of excess air in flue gas from combustion of 100 volumes of gas.

And $\frac{cd}{100} + e + f$ = total volumes of flue gas from combustion of 100 volumes of gas.

The percentage of CO₂ is therefore

$$\frac{\text{vols of CO}_2 \times 100}{\text{Total volumes}}$$

$$\text{Or } \frac{100f}{\frac{cd}{100} + e + f} = \text{per cent CO}_2 \quad (5)$$

To illustrate, assume 9.8 per cent excess air to be present, and from Table II, assume 525.4 volumes of air are required for combustion of 100 volumes of gas, 417.4 volumes of N₂ produced, and 51.9 volumes of CO₂ produced.

$$\begin{aligned} \text{Then } d &= 9.8 \\ c &= 525.4 \\ e &= 417.4 \\ f &= 51.9 \end{aligned}$$

Substituting in equation (5)

$$\frac{59.9}{\frac{525.4 \times 9.8}{100} + 417.4 + 51.9} = 9.96\% \text{ CO}_2$$

In this manner a series of values may be obtained for the combustion of any gas, and the percentage of CO₂ plotted against the percentage of excess air, giving

a means for readily obtaining the percentage of excess air from the percentage of CO₂ in the flue gas. This has been done in Fig. 2 for the coke oven gas previously mentioned. The above method and calculations for obtaining the excess air from the percentage of CO₂ hold true only when an excess of air is present, and no CO is formed.

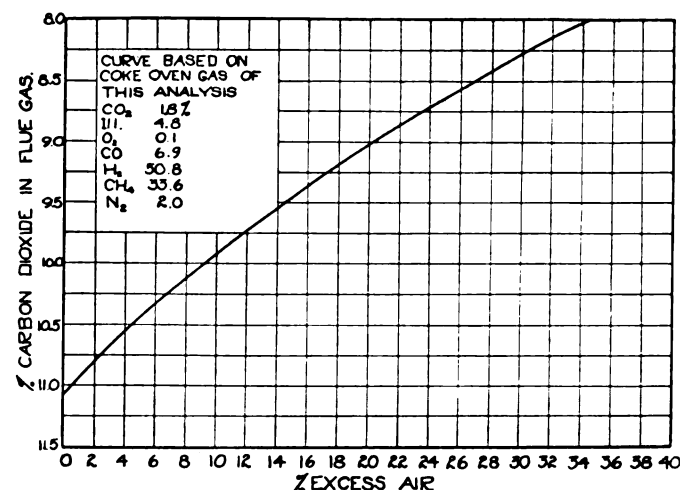


FIG. 2 RELATION BETWEEN EXCESS AIR AND CARBON DIOXIDE IN FLUE GAS.

Applications.

The foregoing methods of calculations are applicable to the combustion of any commercial combustible gas, such as producer gas, blast furnace gas, water gas, etc. A table similar to Table I may be constructed to include any special constituents in the gas other than those given in Table I, such as benzols in unscrubbed coke oven gas, various oil decomposition products in carburated water gas, etc. The equations given may be applied exactly as has been done in the case of the coke oven gas mentioned, since they hold true for any combustible gas.

Summary.

The chemical equations for combustion of the various constituents of coke oven gas are given, and from these a set of tables has been derived for the calculation of the amounts of the various gases produced by or required for the combustion of coke oven gas. Equations are derived for the calculation of the relation between the percentage of oxygen in the flue gas and the percentage of excess air, and also between the percentage of carbon dioxide and the percentage of excess air. Typical calculations are made for the case of a certain coke oven gas, and curves are derived for the ready calculation of the percentage of excess air from either the percentage of oxygen or carbon dioxide in the flue gas. The methods and equations given are applicable to any commercial combustible gas.

Vanadium, a Chemical Curiosity Put to Use

(Continued from page 194.)

petual snows of Andean heights, vanadium finds its way into the elevated temperatures of metallurgical furnaces. It imparts to steel qualities which make possible the cutting of metals at speeds so high that the tool glows at a red heat. Its possibilities for service to mankind have only begun to be explored.

—Research Narratives.

THE SAFETY CRUSADE

The Growth of an Idea

Safety Goes Hand in Hand With Close Personal Relationships

By E. BRANSON*

CLEAN wholesome quarters in which to work, with a just wage in reward for a day's fair service; a spirit of equality between officers and employees; a careful consideration of all complaints made by workers; and social clubs within the organization to promote good fellowship—these are regarded as principles of common sense and justice by Carl C. Gibbs, manager of The Indianapolis Malleable Iron Company, a branch of the National Malleable and Steel Castings Company, largest makers of malleable iron castings in the world. They have been applied in the company's plant with the result that the work there is carried on from year to year in an atmosphere of cheerful and helpful co-operation with no labor troubles and no racial disturbances. This last is significant because of the fact that 65 per cent of the 1,200 employees are colored.

One thing Mr. Gibbs does not believe in, however, is paternalism—exercising control over the intimate affairs of his workers. In a recent interview he said: "When I speak of paternalism, I mean the continual attempt to hold employees and keep them satisfied by providing them with a lot of things incidental to their work, for instance a physician for the sick, going into their homes to see if their living conditions are right, placing fancy flower boxes in the factory windows to make the place attractive. I believe it is far more to the point to see that a man receives a wage sufficient for improving his own domestic conditions, but it should not be given unless he in turn willingly gives a fair day's service.

"I have always believed in personnel work, properly applied—seeing that each employee receives a square deal. If any man in our shop has a complaint to make, we encourage his talking matters over with the personnel department, which sees that each case is made the subject of careful and thorough investigation. Of course in stating all these things I am merely explaining the policy that has gradually developed in the growth of the organization. Another thing I have always believed in is a real democracy, the spirit of equality between the officers and employees. It is my belief that if more heads of manufacturing plants, employing large numbers of workmen, were to assume the real responsibility of their own organization, observing a few of the principles I have just mentioned, the so called problem that exists between capital and labor would be solved automatically for the whole country."

In order to insure the employees against injury, the company has laid great stress on its safety-first work, Mr. Gibbs said, with the result that the number of accidents has been so materially reduced that it is

not uncommon now for many months to pass without a lost-time accident. Each day a physician comes to the plant to look after minor injuries that may have been incurred during the day.

A lunch room where warm, wholesome food is served to the employees at noon at very reasonable prices also adds to the general comfort of the workers. On social occasions the dining room is all dressed up in keeping with the occasion and the employees play as energetically as they work. The negro employees have organized The Dunbar Club and the club's Halloween party is an important event to these workers.



CARL GIBBS

A club for white employees holds its celebration at Christmas time with a Santa Claus accompanied by gay gifts of the season. Each of these clubs meets once a month for a social hour and to discuss the business affairs. Bowling teams add to the fun.

"All these things play an important part in keeping up the esprit de corps of the plant," said Mr. Gibbs. "When I go out in the shop a great many people call me by my first name, a manifestation of the democracy of which I have spoken. It accomplishes co-operation, a term often misunderstood. But

*Indianapolis News, Indianapolis, Indiana.

throughout the plant there is the spirit of co-operation because it is the happy thing to do. Although 65 per cent. of our employes are colored we never have racial disturbances. White and colored employes work in the greatest harmony. The colored people are efficient and loyal workers; in fact we have a number of colored foremen in different departments of the plant."

The Indianapolis Malleable Iron Company was the first of the group included in the national organization to establish a personnel department and to employ women extensively. In 1903, women first were employed in the trimming room. Gradually they have been placed in the core, shipping and finishing departments and in the laboratory until today the white workers act as sorters of castings, inspectors and core makers while the colored women operate many of the heavy presses.

In the same year The National Malleable Castings Company established a works and experimental laboratory in the Indianapolis plant and it is said that this laboratory was the first to successfully exercise complete works control on the basis of the total carbon content being the determining factor in the quality of the product.

Mr. Gibbs became associated with the company in 1906, entering its employ as correspondent in the sales department. "The first real job I ever had was when I became assistant to the sales manager," said Mr. Gibbs. "During one slack season I prevailed on the management to allow me to work in the shops so that I could learn the practical side of the business. I spent half a day working in the shop and the other half day in the office, for about a year. Later I took up the real saleswork and in 1919 was transferred to Cleveland as sales manager of that plant. In 1920 I again returned to Indianapolis, this time as manager of the plant."

The National Company with which Mr. Gibbs is associated operates seven large malleable iron casting plants located at Cleveland, Ohio; Chicago, Illinois; St. Louis, Missouri; Toledo, Ohio; Indianapolis, and two large steel plants, one at Sharon, Pennsylvania, and the other at Melrose Park, Illinois. The company is an Ohio corporation with a capitalization of \$30,000,000.

The Indianapolis plant was organized in 1882 when a group of business men, owners of the Cleveland Malleable Iron Company, and the Chicago Malleable Iron Company, took over the (Isaac) Johnson Malleable Iron Company to increase their manufacturing facilities. They began the manufacture of castings for the Ewart Manufacturing Company, now a part of the Link Belt Company, that had only recently been organized to make detachable link belting. Original directors and officers of the company included John C. Coonley, president; John H. Whittemore, vice-president, and Alfred A. Pope, secretary-treasurer. Mr. Pope after became the president of the National Malleable Castings Company and continued in this capacity until his death in 1913.

"As rapidly as men found employment in the iron works, they acquired homes in Haughville. It would have been a difficult matter a few years ago to have found any person who either had not worked in the shop or who did not possess a relative who had done so. In May of this last year, a picture was taken of a group of men in the plant whose combined continuous service totals 621 years."

Today Haughville, now a part of Indianapolis, fairly throbs with industrial activity and the employes of the Malleable Iron Company ride to the plant in street cars, motor buses and in automobiles.

The plant covers fourteen acres of ground with ten different departments. Its capacity is 18,000 tons a year. At the present time a new addition to the building is being erected at a cost of \$125,000. The principal purpose of the new structure is to provide better working conditions for the employes. It covers 50,000 square feet of floor space consisting of cast iron floor plates and will include eighteen annealing furnaces. The building is of high and low bay type of construction with operated steel sash in each monitor. A steel frame, tile roof, brick and plaster side walls make the addition as nearly fireproof as it possibly could be.

When Mr. Gibbs was asked his rules for attaining success he said, "The real answer to success, I believe, is first to find the kind of work one enjoys most doing and then applying one's self thoroughly to the job."

Will Chippers Wear Goggles?

By W. H. Steele*

Believing that our experience will hold interest for other employers of Pennsylvania, I submit some information concerning the experiences of the Locomotive Stoker Company of Pittsburgh in inducing employes to wear goggles.

This company has always been interested in safety. It carries its own compensation insurance, and in case of an accident pays fifteen dollars a week to an injured employe from the date of the accident, together with unlimited medical or surgical service when needed. It has, also, inaugurated an old age service pension, a dependency pension plan, group insurance, and a sickness relief plan.

The company considers all of these institutions good safety measures, and the record for the past nine years, during which time some 12,000,000 man hours were worked, shows no fatalities, and partial permanent disabilities of only one eye loss, and a total loss of five fingers.

In the early days we had all manner of trouble in the chipping room of our iron foundry in trying to get the men to wear goggles. Our hospital reported large numbers of "foreign particle" cases, and the men absolutely refused to wear goggles. We posted literature, extracts of the law; and we threatened dismissals. Even the periodical visits of the State Factory Inspector did not help matters.

During this period a kind fate seemed to be watching over us because all of our accident cases were entirely of a minor nature.

This problem, however, like all safety problems, is very easy of solution when properly understood in all its ramifications.

We finally decided to try a little psychology. Instead of threatening these men, we merely filled our pockets with as many different designs of safety goggles as we could find, went to those men, talked to them, showed them all the different varieties of goggles, and let each man make his own selection. We then fitted the goggles to each man's face very carefully so that he was comfortable while wearing them.

(Continued on page 220.)

*Shop Engineer, Locomotive Stoker Co., Pittsburgh, Pa.

CURRENT REVIEW

Iron and Steel Production

THE United States still dominates the world in production of iron and steel. In 1924 this country produced nearly half of the world's output of pig iron and more than half of the steel ingots and castings. In the first months of the year it looked as if the United States would exceed all previous records in output but the slowing up of the industries during the summer and early fall was responsible for the relative decline as compared with production in European countries. At the time when depression struck the American iron and steel industry Europe was stimulated by marked improvement in iron and steel buying as a result of extended credit and a degree of general economic stabilization. This state of affairs enabled Europe to forge ahead of 1923 while the United States remained at a relative standstill.

In no year since the war has world output of pig iron equaled that of 1913. It is significant that the United States is responsible for the total net decline in pig iron production from the 1923 level, all other countries having produced in 1924 a total of 33,630,000 tons against 26,445,000 tons in 1923, or an increase of

27 per cent. In the case of steel also the decline in output in the United States was responsible for the net decline in world output as compared with 1923. Table A shows world production of pig iron and steel by countries in 1913, 1923, and 1924.

It has been estimated that in the last 10 years Europe has not on the average consumed commercially one-eighth as much steel as is consumed in the United States per capita. At present 27 countries of Europe are behind not only in railroad construction but in practically all other steel-consuming industries. Potential demand is, therefore, likely to be relatively greater in Europe than in America.

Europe with its tremendous capacity for consuming iron and steel is still producing 14,000,000 tons less of pig iron and about 9,000,000 tons less of steel ingots and castings than were produced in 1913. The United States on the other hand turned out about the same quantity of pig iron as in 1913 and 6,500,000 tons more ingots. In other words, in 1924 this country, although producing less than in 1923, exceeded its prewar output while Europe, although gaining over 1923, produced considerably less iron and steel than in 1913.

A notable development of 1924 was the fact that France passed Great Britain as a producer of pig iron. It must be considered, however, that France acquired 30 per cent of Germany's blast furnace capacity and two-thirds of German ore reserves in the redistribution of territory after the war. This in part accounts for the increase in 1924 of French output over that of 1913, but there was basic improvement in 1924 as compared with 1923. Output of Belgian pig iron and steel in 1924 was considerably above the prewar level for the first time since 1913. Great Britain, being more dependent on foreign markets, in 1924 produced 2,860,000 tons less pig iron than in 1913, although its steel output exceeded the prewar level.

The shifting of so much iron and steel capacity from Germany to France, while affecting the trade relations of certain European countries, is not expected to affect permanently the situation in America. Europe has the potential capacity to consume all the steel it can produce with existing facilities. The present situation as to surpluses in some of the countries is said to be a result of underconsumption in the markets normally supplied rather than a result of overproduction. The exportable surplus of 5,000,000 tons of iron and steel which France now has results more largely from the change in boundaries than from any net increase in Continental output.

Low exchange rates in France and Belgium together with favorable working conditions enabled those countries to export record quantities of steel

TABLE A
World Production of Pig Iron and Steel Ingots and Castings¹

	1913	Pig Iron		Steel		
		1923	1924	1913	1923	1924
		(in thousands of gross tons)				
United States...	30,653	40,026	31,000	31,301	44,944	37,800
Canada	1,015	909	700	1,043	885	725
Great Britain...	10,260	7,440	7,400	7,664	8,482	8,400
France	†5,126	5,346	7,500	†4,614	5,029	6,850
Belgium	2,428	2,154	2,800	2,428	2,250	2,850
Luxemburg ...	†	1,384	2,125	†	1,182	1,850
Italy	420	243	250	810	1,100	1,100
Spain	418	394	400	381	453	475
Sweden	730	273	300	582	294	400
Germany	†\$19,000	4,400	8,200	†\$18,631	5,900	8,500
Austria	†2,343	339	350	†2,584	491	550
Czechoslovakia.	†	750	700	†	1,000	800
Poland	§	492	500	§	935	950
Hungary	†	295	300	†	344	350
Russia	\$4,486	315	330	\$4,760	492	600
Japan	56	300	350	13	500	550
China	*	375	375	*	200	200
India	*	536	550	*	215	225
Australia	47	300	300	*	200	200
Miscellaneous .	200	200	200	100	200	200
Total.....	77,182	66,471	64,630	75,019	75,096	73,575

¹ Compiled by Iron Trade Review.

† Not strictly comparable with postwar figures.

‡ Figures for Luxemburg included with those for Germany.

§ Figures for Poland included with those of Germany and Russia.

¶ Figures for major portions of Czechoslovakia and Hungary included with those of Austria.

* Accurate data not available.

last year. The heavy exports of steel from France to Germany were in part the advance effect of the proposed 50 per cent increase in the German tariff over the prewar rate, effective January 10, 1925. Great Britain, however, handicapped by labor difficulties and rising exchange rates, exported 464,000 tons less of iron and steel than in 1923.

TABLE B
Estimated World Capacity for Iron and Steel Production

	Pig Iron	Steel	Per cent of Total	
	(in thousands of gross tons)		Pig Iron	Steel
United States	52,700	59,000	53.4	56.1
Germany	12,000	14,000	12.2	13.3
Great Britain	12,000	12,000	12.2	11.4
France*	11,000	10,000	11.1	9.5
Belgium	3,250	3,250	3.3	3.1
Luxemburg	2,800	2,000	2.8	1.9
Other countries . .	5,000	5,000	5.0	4.7
Total	98,750	105,250	100.0	100.0

*Including the Saar Basin.

Table B shows the approximate capacity for pig iron and steel production in each of the six principal producers and estimates for others. In 1913 more than 90 per cent of United States production was consumed in the domestic market and in 1924 about 95 per cent. On account of the broad domestic demand resulting from rapid industrial recuperation and development the share of the United States in world exports of iron and steel has declined considerably from the 1913 level.—Commerce Monthly.

All-Steel Houses in Britain

By Joseph Horton

The most interesting feature of the British Industries Fair is an exhibit by Braithwaite & Co. Ltd., engineers. This comprises two sample houses of the Telford all-steel type. Some 70 municipalities have sent representatives, generally housing committees,

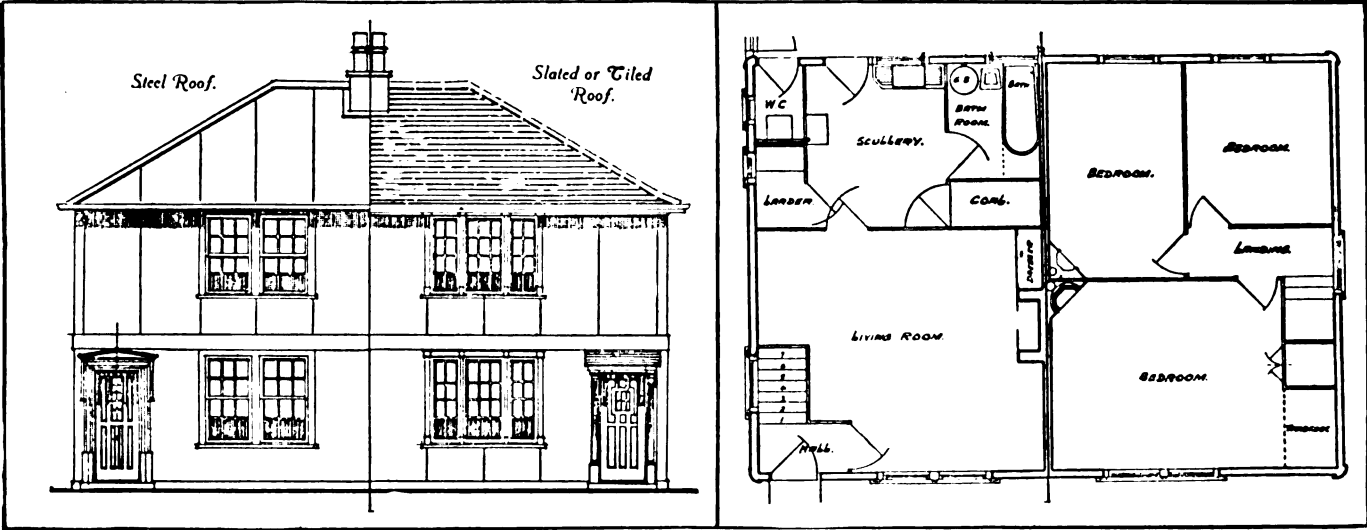
such houses for the subsidy granted by the government under the Housing Acts of 1923 and 1924. The country is really becoming in earnest over the question of a house shortage, and it seems likely that this type of dwelling will be largely adopted. Previous experiments with all-steel houses in Great Britain have met with success.

Braithwaite & Company, engineers have built piers, bridges, etc., in many parts of the work. As business is slack in their own line they have taken up house building on a large scale. The Telford house, designed by J. C. Telford, general manager, Braithwaite & Company, is built without the aid of bricklayers, plasterers or other skilled trades, in which there is a decided shortage of labor. The whole of the work is done by unskilled labor, every component being manufactured at the works before being bolted together on the site. The principal material is steel plate, 1/8 in. thick, which is covered with thick asbestos lining sheets, secured to the framework.

Between the outer steel plates and the inner asbestos sheets is hung an intermediate protective lining fixed to the back of the inner framework. The windows are steel casements with wood frames, and doors, cupboards, etc., are of wood. Chimney breasts, etc., are of steel construction similar to the main walls. Flues and chimney heads are made of cast iron. The roof is of steel plates, though it may be constructed in the ordinary way of slate or tile, or other covering.

In order to obtain equable temperature there is a sealed cavity 6 in. wide between the outer walls of steel and the inner walls of asbestos. Arrangements are made also for the circulation of heated air from the chimney flues throughout the cavity. The sealing of this space is considered an effective safeguard against vermin.

The steel plates are 3 ft. 6 in. wide, fitted together on a concrete platform forming the ground floor, and the plates are bolted into the concrete. The steel walls are carried to their full height and bolted both to the platform, and vertically. The outer walls of



to inspect the houses. At present 200 are on order, of which Bolton is taking 100, Bristol 40 and Birmingham, eight. A large number of the other municipalities have instructed the company to put up samples. An important basis for success is the approval of the ministry of health qualifying the builders of

steel are prepared and painted on the exterior with a special rust-resisting paint, finished in a warm stone color, and sprinkled with sand while wet. The inner face of the steel is protected against rust by a bituminous or other coating. The inner lining is secured in position by hardwood fillets and brass, screwed

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to the framing, this lining being papered if desired. If required the ground floors may be boarded.

A pair of houses can be erected complete ready for occupation in ten days after the laying of the concrete foundation. The cost of each house amounts to £460 (\$2,194), which is about the same cost as a brick structure. In each house seven tons of steel is used.

Technical Articles

One machine per man per day; Ohio tool builder applies production methods of automobile industry to washing machine department.

Better highways use more steel in 1925 programs; estimate road building projects of 1925 involve an expenditure of \$100,000,000 and will require 500,000 tons of steel.

Sales methods built \$15,000,000 annual business from basement workshop in 20 years.

Know better than guessing when bidding for contracts; estimates not consciously below cost, but ignorance of cost methods brings losses to fabricators; estimating on pound basis is unsafe.

Law of market areas explained; formula evolved for determining progressive effect of freight rates on competitive conditions, by Frank A. Fetter, economist of Princeton university.

Tests dust catcher efficiency; iron ore carried out of a blast furnace frequently totals 4 per cent of the weight charged.

Tracing losses through furnace walls; a treatise by M. L. Hartmann and O. B. Westmont, research director and chemist, Carborundum Company, Niagara Falls, N. Y.

Drastic quenching imparts surprising properties to bolts and rivets; an account of an Ohio manufacturer's experiments in quenching.

Designing the pickling department for economy in maintenance; a series of three articles dealing with pickling practice and equipment by C. A. Crawford, International Nickel Company, New York.

What users want in machine tools; by Robert R. Keith, chief engineer of motor trucks and busses, International Harvester Company.

Build sales by improving layout of selling territories; by G. E. Bittner, domestic commerce division, Department of Commerce.

Salvaging header dies affords larger unit production.

Carbon control gages strength.

Cuyuna ores more in demand, by Carl Zapffe, geologist, Northern Pacific Railway.

House organs reducing sales resistance; plant publications aid goodwill spirit; an account of the company publications in the United States.

Electric heating for manufacturing processes assumes importance.

—IRON TRADE REVIEW.

Current Literature on Ferrous Metallurgy

By E. H. McClelland*

Analysis of defective castings. E. Longden. *Foundry Trade J.*, v. 31, Mar. 5-12, 1925, p. 208-210, 229-232.

Discussion March 26, p. 271-272. Concerned primarily with gray iron, but largely applicable to castings in general.

Belgian coal, iron and steel industries in 1924. *Iron and Coal Trades Rev.*, v. 110, Mar. 20, 1925, p. 469.

Beneficiation tests. W. B. Timm. *Iron and Steel of Canada*, v. 8, Feb. 1925, p. 43-46.

Beobachtungen bei der kugeldruckprobe nach Brinell. M. Moser. *Stahl u. Eisen*, v. 45, Mar. 5, 1925, p. 343-344.

Brief history of metallurgical practice in cannon-making with particular reference to the cast-iron gun. Job Goostray, R. F. Harrington and M. A. Hosmer. *Trans. A. I. M. and M. E.* (Advance paper No. 1420-C, issued Mar. 1925, 22 p.)

Carbon control gages strength. James Ward. *Foundry*, v. 53, Apr. 1, 1925, p. 281-282.

Chemistry of iron and steel. F. T. Sisco. *Trans. A. S. S. T.*, v. 7, p. 494-517.

Part 3 of serial. Discusses chemistry of basic open-hearth, acid open-hearth, acid electric, and basic electric processes. An excellent summary.

Combustibility of blast furnace coke; further experiments based on the composition of gases; size of coke and rate of air supply; beehive coke and charcoal. Ralph A. Sherman. *Iron Age*, v. 115, Apr. 9, 1925, p. 1043-1045.

Continuous annealing furnace at Bryngwyn, sheet-works. *Iron and Coal Trades Rev.*, v. 110, Mar. 6, 1925, p. 397.

Cutting steel mill maintenance costs with the welding arc. A. M. Candy. *Iron and Steel Engineer*, v. 2, Mar. 1925, p. 122-125.

Designing the pickling department for economy in maintenance. C. A. Crawford. *Iron Trade*, v. 76, Apr. 2, 1925, p. 875-877.

Serial.

De-sulphurisation, expulsion of gases and refining of cast iron. G. C. Castle. *Foundry Trade J.*, v. 31, Mar. 19, 1925, p. 248.

Distribution of graphite in cast iron and the influence of other elements on its strength. Matsujiro Hamasumi. *Foundry Trade J.*, v. 31, Mar. 19, 1925, p. 239-243.

From *Science Reports* of Tohoku Imperial University.

Drastic quenching imparts surprising properties to bolts and rivets. E. L. Shaner. *Iron Trade*, v. 76, Apr. 2, 1925, p. 871-874.

Einwirkung des sulfidgehaltes auf die eigenschaften von hochofenschlacken und hüttenzementen. Richard Grun. *Stahl u. Eisen*, v. 45, Mar. 5, 1925, p. 344-346.

Electric arc welding in the steel industry. W. R. Warner. *Iron and Steel Engineer*, v. 2, Mar. 1925, p. 115-119.

Electric furnace. H. Burton Smith. *Iron and Coal Trades Rev.*, v. 110, Mar. 20, 1925, p. 474.

Electric pig-iron manufacture in Sweden. J. A. Leffler. *Iron and Coal Trades Rev.*, v. 110, Mar. 27, 1925, p. 510-511.

Electrification of a 10-in. rolling mill. *Iron and Coal Trades Rev.*, v. 110, Apr. 3, 1925, p. 550.

Electrolytic iron; the production of iron and sulphur from sulphide ores of iron and the recovery of the precious and base metals. F. A. Eustis. *Iron and Steel of Canada*, v. 8, Feb. 1925, p. 27-31.

Equipment and methods in die-casting; present stage of development in casting of metals in permanent dies under high air pressure; comparison of die-castings with machined parts. Donald L. Colwell. *Iron Age*, v. 115, Apr. 9, 1925, p. 1052-1054.

Serial.

(Continued on page 225.)

*Technology Librarian, Carnegie Library of Pittsburgh.



Turbine Blade Manufacture

An Opportunity to Observe the Development of This Important Industry is Afforded the Technical Staffs of Leading Journals

PRIOR to 1918 the manufacture of steam turbines, condensers and auxiliaries was carried on by the Westinghouse Electric & Manufacturing Company at one plant only, East Pittsburgh. The rapid growth of the electrical industry and the limited room available at East Pittsburgh for factory extension made necessary an additional plant for the company in a new location, for which in 1916 the Philadelphia district was selected.

The plan contemplated moving all steam turbine manufacturing facilities to the South Philadelphia Works, this move, however, was a gradual process begun in 1918 and completed by 1920, with the exception of the manufacture of turbine blading, which remained in operation at East Pittsburgh until its transfer to South Philadelphia Works during the summer and fall of 1924.

Editors of a number of the leading technical and trade publications of the country visited and inspected the South Philadelphia Works on Wednesday and Thursday, April 15 and 16.

The inspection tour covered the entire works, in which the large apparatus for use in the generation of steam for power purposes are designed and constructed, but the visitors were particularly interested in the new turbine blading shop, which represents a total investment by the Westinghouse Company of approximately \$1,000,000.

The visit of technical and trade editors to the new Turbine Blading Shop marked the first formal visit of industrial men other than officials and executives of the Westinghouse Company.

Arriving at the South Philadelphia Works on Wednesday morning, April 16, the party in company with Westinghouse officials and plant executives made a tour of inspection of the entire plant. At the noon hour an informal luncheon was held in the private dining room. At this time, editors and plant executives were enabled to exchange views regarding industrial problems and the Westinghouse executives and engineers explained the purposes of the transfer of the shop to South Philadelphia.

In the afternoon, the party inspected the Turbine Blading Shops in company with escorts, selected by the plant management to give the editorial writers such detailed information on operation, machining processes, processes of manufacture, dies, etc., as they particularly desired.

Wednesday evening, the editors were guests of the Westinghouse Company at a private dinner in the rooms of the Art Club, South Broad Street, Philadelphia. Following the dinner, addresses were delivered by Mr. H. T. Herr, vice president of the Company in charge of the South Philadelphia plant; J. C. McQuiston, Manager of the Department of Publicity, and several of the editors.

The keynote of the addresses was that this visit marked a stepping stone toward bringing the manufacturer of large electrical and steam apparatus and the editorial writers in close touch with each other's problems and that an interchange of ideas would result in mutual understanding and co-operation.

Vice President Herr spoke quite freely regarding problems of the manufacturer of turbines and expressed appreciation of the opportunity for the Westinghouse executives and officials to discuss their problems with editors, who are in touch with the trade, to which the manufacturer sells his products.

Thursday morning was spent in collecting additional information for their various technical magazines. An informal golf tournament on the links of the Philadelphia Country Club, occupied the afternoon. A dinner at the Country Club closed the two-day visit.

The manufacture of blading at East Pittsburgh had its inception coincident with starting the development work in this country on the Westinghouse Parsons Steam Turbine, in the closing years of the nineteenth century. Its beginnings were simple and on a small scale, consisting of cutting off reaction blades of drawn section to required length. Packing or spacing pieces were also sheared from section drawn to fit the blade contour, the length of packing corresponding to the depth of blade groove in the turbine spindle and cylinder. The reaction blading and packing were inserted in the groove, driven up snugly by lateral compression, and finally when the row was closed the packing was carefully caulked into place.

From this simple beginning the blade design and manufacture has passed through a gradual and elaborate development both as regards methods and ma-

terials, embracing highly specialized machine forging, drop forging, rolling, drawing, punching, broaching and milling operations, heat treatments, etc., and running the gamut of materials from carbon steel and simple brasses and bronzes to highly developed alloy steels and special non-ferrous materials. Certain phases of the evolution and development of blade design and manufacture will be discussed elsewhere under appropriate headings.

Development of facilities for blade making having in recent years reached a reasonably stabilized condition, it became entirely feasible to plan a factory for balanced and co-ordinated manufacture and for this purpose a committee was appointed to make a comprehensive study of the size, character and arrangement of facilities for present and reasonable anticipation of future needs.

The site selected for the new Blade Shop can be seen in the aeroplane view shown on the title page.

The Blade Shop as built consists of a one-story portion brick and steel construction, extreme length 500 feet by 145 feet wide; at its west end the one-story portion is joined to the two-story portion, the latter forming an acute angled L.

The two-story building of concrete, steel and hollow tile construction, 320 feet by 130, has a floor area of 84,700 sq. ft., and the Blade Shop as a whole 146,550 sq. ft. The buildings were erected by the U. G. I. Contracting Company.

By way of introduction to the plan of manufacturing, flow of product and arrangement of machinery, whereby production is carried on, a brief description of the salient features of the principal lines of blading product is in order.

Reaction Blading—Standard Manganese Copper

The blading material most employed in Westinghouse turbines in point of quantity of pieces, which through years of service has demonstrated its re-

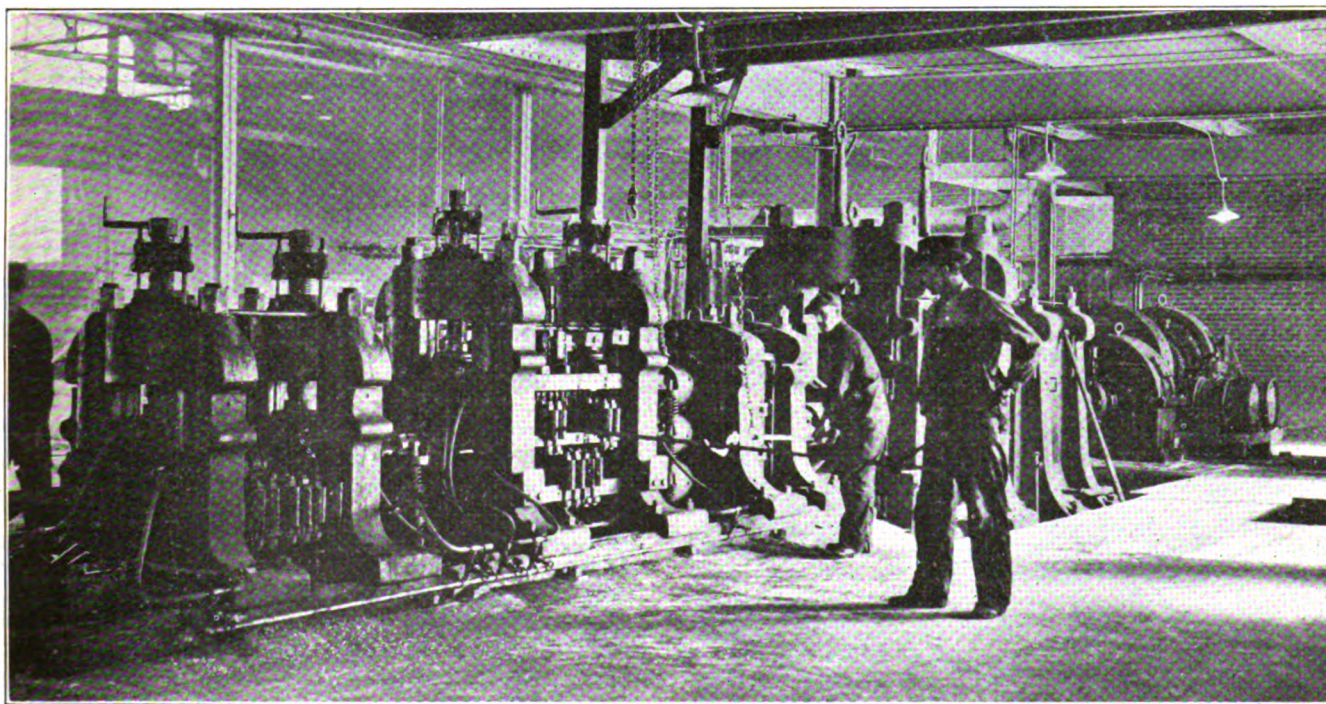


FIG. 2.—Shows an excellent view of the 12-in.—18-in. bar mill.

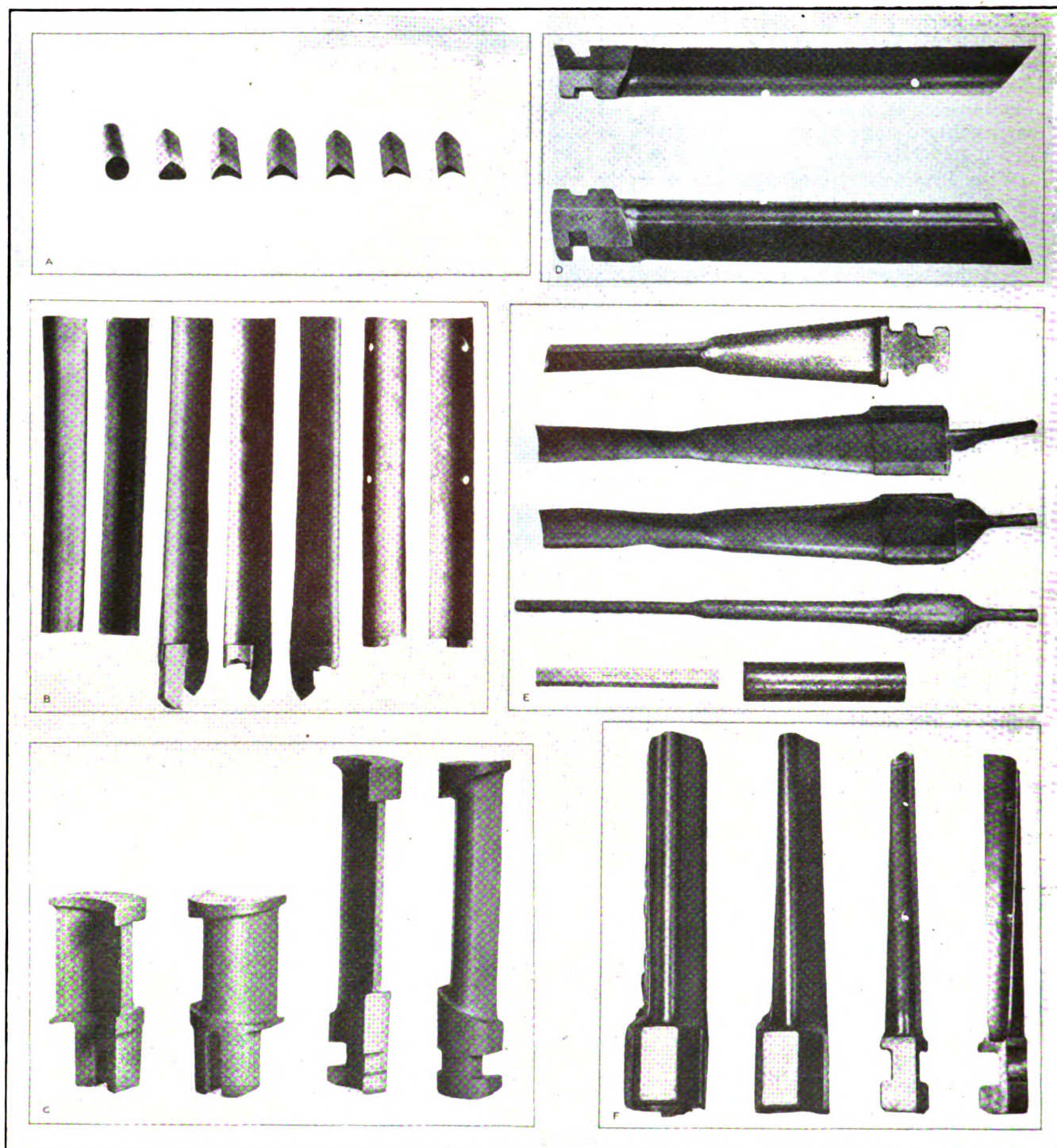


FIG. 3.—(A) Blade section rolled from round bar; progressive steps in manufacture. (B) Reaction blade stages in manufacture. (C) Impulse blades. (D) Steel reaction spindle blade; standard parallel section. (E) Drop forge multiple exhaust blade (row 52) progressive steps in manufacture. (F) Special twisted tapered blade (8 and 10).

liability within its proper operating range of stress and temperature, is manganese copper, which consists essentially of 5% manganese, the balance copper.

Securing in place turbine blading has been a gradual evolution. The securing of blading in the grooves by caulking in place served its purpose until supplanted by a more positive method of fastening made necessary by reason of increased blade speeds and higher stresses. The improved method of fastening, which was developed and made standard since 1911, employed an upset hook at the base of the blade and a dovetailed packing which locked in a corre-

spondingly angled groove. The hook is produced by upsetting in a commercial type of bolt heading machine operating laterally-closing dies and an endwise-moving punch or ram. Incidental to upsetting the hook, the blade bases are upset or thickened to a suitable tapering reinforcement to insure added structural strength at and near the base. The packing pieces are of soft carbon steel rolled and drawn to section, sheared to length, and broached to dovetail. Certain other materials such as pure nickel admit of fabrication in the upsetting machine similar to manganese copper, though with somewhat less facility.



FIG. 4.—(Upper left) Upsetting machines. (Upper right) Electric heat-treating furnace. (Center left) Oil storage tanks and pump house. (Center right) Reheating furnaces. (Lower left) Dressing drop forged dies. (Lower right) Bradley hammer and furnace.

Impulse Blades

These are fabricated by either of methods (a) milling from bar stock, whereby the port is milled out on revolving drum fixtures and (b) drop forging and hot swaging with suitable dies in a forging press concluding with milling operations for base and edges. Close limits of precision are required in either case. The finish is such that the curved surfaces nest together to proper pitch without milling or other machine finish. Each graduation of the scale represents

one thousandth of an inch in pitch thickness. Individual blades of a set may depart from standard in thickness of pitch not to exceed .005 inches, but in all cases blades gauging plus, must be compensated for by corresponding blades gauging minus, so that the algebraic sum of all departures from standard for a full circle or row shall be zero.

Low Pressure Blades of Parallel Section.

Where the necessities of design do not require extreme length for a low pressure blade but are beyond

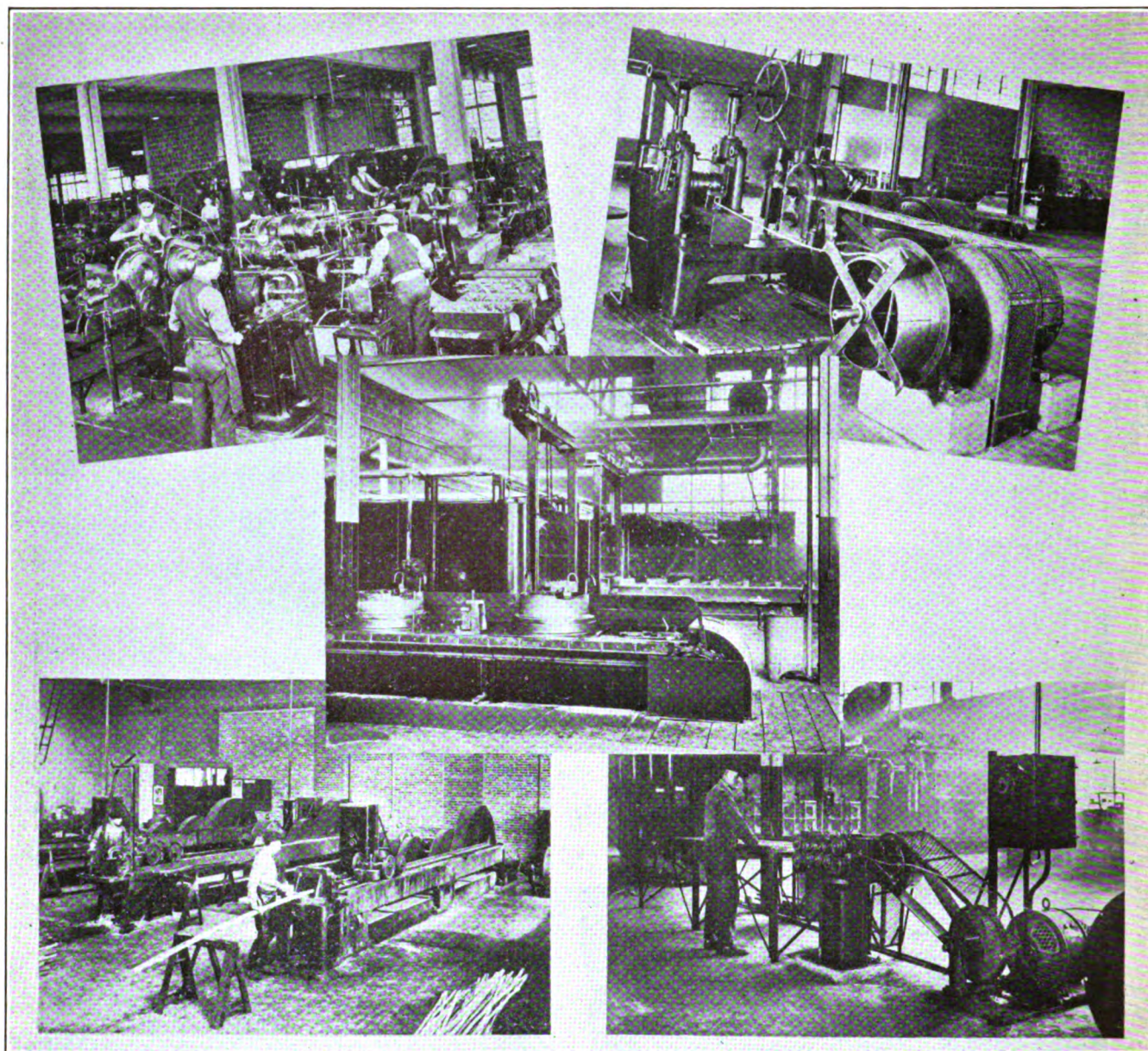


FIG. 5—(Upper left) Machine operations. (Upper right) Small rolling mill and reel. (Center) Draw-bench—reel type. (Lower left) Large draw bench. (Lower right) Straightening rolls for drawn stock.

the range of physical qualities of manganese copper; standard practice employs a blade of straight parallel section, usually of 5 per cent nickel steel, drop forged, for moving rows. For stationary rows a parallel section in manganese copper in general is used. Although this latter blade is essentially of parallel section, its base is reinforced by upset thickening to afford additional strength at and near the root.

Forged Low Pressure Reaction Blades of Special Types

In recent designs of Westinghouse turbines of large capacities, low pressure blades of 20 to 24-inch length and even longer have been used. Owing to the stresses due to high peripheral speeds, also owing to radial angularity between the long blades, departure in certain instances from a straight parallel blade section has been effected in two particulars: (a) The blade has been tapered to keep down the weight and stresses due to centrifugal force, and (b) The blade has been twisted or warped for two reasons in order

that, 1st, The inlet angle may permit the steam to be received tangentially at all points throughout the length of the blade, and 2nd, The passage between the blades may be of such shapes throughout the length of the blade as to give the requisite nozzle effect in guiding the steam through the blades for best efficiency.

Blades also of warped and special characteristics are used in connection with designs employing the multiple exhaust principle.

Not only is the forging of these blades an undertaking of unusual refinement, but the machining requires a high degree of precision in workmanship, as well as specially developed devices and fixtures.

Development of Models and Dies for Warped Blades

In working out methods of preparing models and cutting drop forge dies for blades for the multiple exhaust design, an expression of appreciation is due the Keller Mechanical Engineering Corporation of

Brooklyn, New York, for assistance and co-operation in an undertaking of no small difficulty or magnitude.

Each cross section of blade to be modeled has its appropriate contour gauge made of $\frac{1}{8}$ inch sheet steel and fitted with extreme precision to lapped and ground steel templates or master pieces.

Modified Type of Warped Blade

A modified type of warped and tapered blade has been developed by our engineers which while embodying the main characteristics of a hand modeled blade has the advantage of greater facility in preparing and maintaining the forging dies. The surfaces which give the effect of a twist are developed by planer or shaper cuts no models nor engraving machine work for this design being required. These cuts with non-intersecting axes diverge at the base and converge at the tip employing suitably shaped form tools by means of which the required taper and twist are obtained.

Stationary Reaction Low Pressure Blades of Manganese Bronze

A process which lends itself well to the fabrication of large section, low pressure, stationary blades where taper, twist and in some instances where a dividing partition for multiple exhaust are required consists of casting such blades in manganese bronze and grinding the surfaces to the required limits of shape and section thickness. This material has demonstrated its fitness for the purpose and the process has been worked out with entire satisfactoriness.

Larger sections of packing and blading are rolled in 12-inch and 18-inch mills shown, Fig. 2, in a continuous train driven by a 350 HP Westinghouse motor through reduction gearing.

Fig. 3 shows various machine operations on drawn reaction blades subsequent to upsetting.

Bradley Helve Hammer for breaking down the bar stock preparatory to drop forging is shown, lower right in Fig. 4.

Fuel oil is used in furnaces serving the helve and drop hammers and rolling mill. Oil is received in tank cars. Storage tank and oil pump house are shown suitably protected by sodded embankment in left center Fig. 4.

Heat treatment of finished forgings is carried on by means of Westinghouse electric furnaces, Fig. 4, upper right, equipped with recording pyrometers. The forgings are brought up to 1,450 deg. F. quenched in oil, again brought up to 1,050 deg. to 1,200 deg. F. and cooled in oil.

Draw benches are used in drawing certain sections of packing pieces and blading to section. Fig. 4 shows the bar type for the heavy work, and also the reel type for the lighter sections.

Rolls for straightening lighter drawn sections are shown in Fig. 4, lower right.

Pittsburgh Valve, Foundry & Construction Company, Pittsburgh, Pennsylvania, manufacturers of valves, fittings, bends, etc., specializing more particularly on power house piping, have moved their Chicago sales office, Mr. J. B. Longini, district representative, from the Monadnock Block to Room 502 Railway Exchange Building, which is located at the northwest corner of Jackson and Michigan Blvds.

STRUCTURAL STANDARDIZATION

The story of the construction economies that are being effected through standardization and simplification in the structural steel industry has just been told to audiences of engineers, architects, structural steel fabricators, contractors and business men, in 10 cities of the South, West and Western Canada by Lee H. Miller, chief engineer of the American Institute of Steel Construction. On the speaking tour which began at Atlanta, Ga., March 6, and ended with his address in Winnipeg, April 6, Mr. Miller not only outlined the results that have already been accomplished through operation of the Institute's Standard Specification and Code of Standard Practice, but held conferences in which the technical and engineering phases of the organization's work were developed.

Mr. Miller's speeches sounded the note of construction economy through standardization in the structural steel industry by explaining the significance of the work being done by the American Institute of Steel Construction. He traced the history of the steel industry from its earliest beginnings down through the development of the open hearth method, and the evolution of the skyscraper. He described the confusion that crept into the industry through utter lack of standardization of specifications and practices. He then told of what has been happening since the institute came forward with the Standard Specification and the Code of Standard Practice, and called attention to the fact that in the last two years more than 30 leading cities of the United States have written the provisions of the standard specifications into their building codes, and that a like number are now considering its adoption.

Stating that the 16,000-pound unit stress for structural steel was fixed when the Bessemer method was developed, and that no advantage had been taken of the improvement of the product in quality, strength and elasticity since that time until the Institute wrote the 18,000-pound unit into its specification, Mr. Miller explained in detail the development of the formulae on which the new unit is based. He called attention to the fact that the specification makes possible a saving of fully 12 per cent in the amount of steel required for any specific job. This one phase of the economies made possible through the specification and the code of standard practice will result in an economy of \$30,000,000 annually in this country as soon as the new unit stress is generally adopted, he said.

He pointed out that variations of practice in the structural steel industry tend to lower the standards of the industry, whereas standardization can have no other effect than a universal improvement, and insistence upon the highest standards.

In Atlanta, on March 6, Mr. Miller conferred with the structural steel leaders of the Southeast, and addressed a large gathering of engineers, architects, contractors, financiers and others interested in construction. This meeting was arranged by the Institute.

At New Orleans, on March 9, Mr. Miller addressed the largest meeting ever held by the Louisiana Engineering Society. In addition to members of the society, business and professional men interested in the subject attended the meeting.

Mr. C. B. Harvey, formerly branch manager of the Philadelphia territory for the complete line of Lapeer Semi-Trailers, has been appointed distributor for this same territory.

Meeting of Refractories Institute

THE first meeting of the American Refractories Institute was held at the Mellon Institute, University of Pittsburgh, Pittsburgh, Pa., April 14, 1925. Thirty-six manufacturers of refractories and twenty-six technical men and representatives of the consuming industries attended this meeting.

Mr. P. S. Kier of the Kier Fire Brick Company, Pittsburgh, was elected to serve as acting chairman and after the appointment of a Nominating Committee, several talks and technical papers were given. Mr. J. D. Ramsay, President of the Elk Fire Brick Company, St. Marys, Pa., talked on the purposes of the organization, emphasizing the fact that the co-operation of the consumers was necessary for the success of this project and pointing out the benefits to the consumers through the use of the research and testing divisions and the opportunity for presenting problems and complaints before an organized body of manufacturers. Mr. Ramsay has been very active in promoting the American Refractories Institute and his talk aroused enthusiasm among all of those present.

Dr. E. R. Weidlein, Director of the Mellon Institute, spoke on the advantages of research and stressed the fact that no industry could maintain its stability without constantly striving to better its product or lower manufacturing costs. Several concrete examples of this point were cited.

Mr. H. L. Dixon, of H. L. Dixon Company, Pittsburgh, gave an informal talk dealing with his experiences in the use of refractories. Mr. Dixon pointed out that the Refractories Institute would be of great value through the exchanging of ideas between manufacturers and users. The talk was especially interesting because of Mr. Dixon's wide experience and his frankness in discussing some of the causes for unsatisfactory service from refractory materials. The meeting was then adjourned for inspection of the Mellon Institute and luncheon at the University Club.

In the afternoon a paper on methods of cost accounting in the refractories industry was read by Mr. A. J. Farber of Haskins & Sells, Pittsburgh. This was of interest to the manufacturers present, many of whom have been striving to put this phase of their business on a more efficient basis.

The results of a fundamental investigation made to study the physical factors involved in the spalling of fire clay brick were given by Mr. M. C. Booze, Senior Fellow of the Refractories Fellowship, Mellon Institute. It was shown that of the three factors coefficient of expansion, diffusivity, and elasticity the latter was the most important, due to the fact that it could be varied over wider limits than either of the others and also that it was the only one which varied directly with the results of spalling tests. Greater variations in coefficients of expansion for mixtures varying in composition and structure were obtained than was anticipated, but it happened that those with lowest expansion spalled the most readily, proving that this property is not the most important in affecting spalling. The average coefficient of expansion was also found to be lower than the value ordinarily used by engineers in making allowance for expansion of furnace walls.

A technical paper was also given by Mr. S. M. Phelps, Fellow on Refractories Fellowship, Mellon Institute, dealing with the relative thermal efficiency of different types of refractories when used as checkers in regenerators. It was shown that while there was little difference between dense and open textured fire clay brick in the rate at which they heated up or cooled down, the former had greater heat capacity and were accordingly more efficient for use as checkers, the difference being about 6 per cent. in favor of the dense brick after cooling for 20 minutes in a blast of air. Silica brick were shown to be 20 per cent. less efficient than dense clay brick in the same tests.

Mr. J. B. Shaw, head of the new ceramic department, Pennsylvania State College, offered the services of the department for use by the Refractories Institute in conducting research and testing work and promised hearty co-operation with the new organization.

After this program was given, the nominating committee reported and the following men were elected to serve on the Board of Directors:

To serve one year—F. R. Valentine, Woodbridge, N. J.; G. H. Diack, Lock Haven, Pa.; P. S. Kier, Pittsburgh, Pa.; E. F. Myers, Ironton, O.; R. A. B. Walsh, St. Louis, Mo.; F. J. Helwig, Pueblo, Colo.; W. L. Stapler, Atlanta, Ga.

To serve two years—J. M. McKinley, Curwensville, Pa.; C. C. Edmunds, Pittsburgh, Pa.; C. E. Kapitzky, Cleveland, O.; E. M. Weinfurter, Ashland, Ky.; C. S. Reed, Chicago, Ill.; J. L. Green, St. Louis, Mo.; J. T. Roberts, San Francisco, Calif.

To serve three years—G. A. Balz, Perth Amboy, N. J.; J. D. Ramsay, St. Marys, Pa.; J. E. Lewis, Pittsburgh, Pa.; Burrows Sloan, Philadelphia, Pa.; A. P. Taylor, Cincinnati, Ohio; A. P. Green, Mexico, Mo.; H. L. Tredennick, Johnstown, Pa.

The next meeting is to be held in October, the exact time and place to be announced later.

New Immersion Heating Unit

A new immersion heating unit recently developed by the General Electric Company consists of helicoil sheath wire cast into iron. This unit was designed for use in oil tempering baths and melting pots used for melting lead, tin and alloys which will not attack iron.

The units employed for oil tempering baths utilize the cast-in feature only on the portion of the sheath which dissipates heat at the bottom of the tank. On the units for melting pots, however, the cast iron is brought up on the neck of the unit and out of the pot. This neck is heated to allow for expansion of the metal when cold metal is being melted, thus preventing blowups. The cast iron also protects the steel tube of which the sheath wire is made from corrosion by the molten metal. The casting is provided with ribs to increase the radiating surface and to maintain the temperature of the heating unit at a relatively low point.

These units are being made in capacities up to five kilowatts and are sold either individually or incorporated in melting pots and tempering baths.

Flexibility in Power Plant Equipment

Power Plant Equipment Is the Same Irrespective of the Industry

By N. L. DAVIS*

WHERE continuity of operation is of paramount importance, such as in blast furnace operation, flexibility in the power plant equipment is a most necessary quality. While inflexible equipment does not necessarily mean loss of time and the expense of shut-down, a high degree of flexibility does assure continuity of operation as nothing else can.

"Flexibility" defined is: adaptability to varying conditions. From this definition it will be apparent that true flexibility in power plant equipment extends not alone to the generation of power but to the mechanical conveying equipment as well. Quite as necessary as the ability of a boiler room to generate 20,000 kw., (when occasion requires) even though the rating calls for but 15,000 kw., is the ability of the equipment to maintain a constant flow of coal to the grates and make disposition of the ashes.

Where iron meets iron or steel works on steel, there is friction and wear. Hence the necessity for providing means for the elimination of delays and possible breakdowns. Detours, so to speak, around emergencies.

Because power plant equipment is the same regardless of industry, and because boiler room problems are similar irrespective of how the heat or power is used, we have chosen to describe a power plant installation that is in no wise connected with the steel industry or maintenance of blast furnaces. We are making this choice because of the extreme flexibility of the installation and the similarity of application that is possible to any power plant serving the blast furnace field.

The installation described is the power plant of the Riverside Pumping Station, Milwaukee, Wis. This station, recently put in operation, furnishes the pressure by which 35 per cent of Milwaukee's water supply (70 millions of gallons daily) is transferred from Lake Michigan to all parts of the city. It will be seen, upon thought, that this station carries quite as great a responsibility as any power plant for blast furnaces, for while a breakdown in the power station for blast furnaces would cause great loss in time and investment, a break in the continuous operation of Riverside would deprive upwards of a quarter million people of their water supply. Like a blast furnace power plant, therefore, Riverside must be assured continuity of operation.

There is one radical difference, however, between the Riverside plant and any power plant in the steel industry. Riverside is located some distance from a railroad, and must receive its coal by motor trucks of 5 to 7 ton capacity. Therein lies a great difference, but as the possible flexibility of the conveying equipment is, for the most part, important only after the coal has been received at the boiler room, this difference, for the purposes of our discussion, is minor.

Coal is dumped into the receiving hopper covered by a steel grating over which the motor trucks

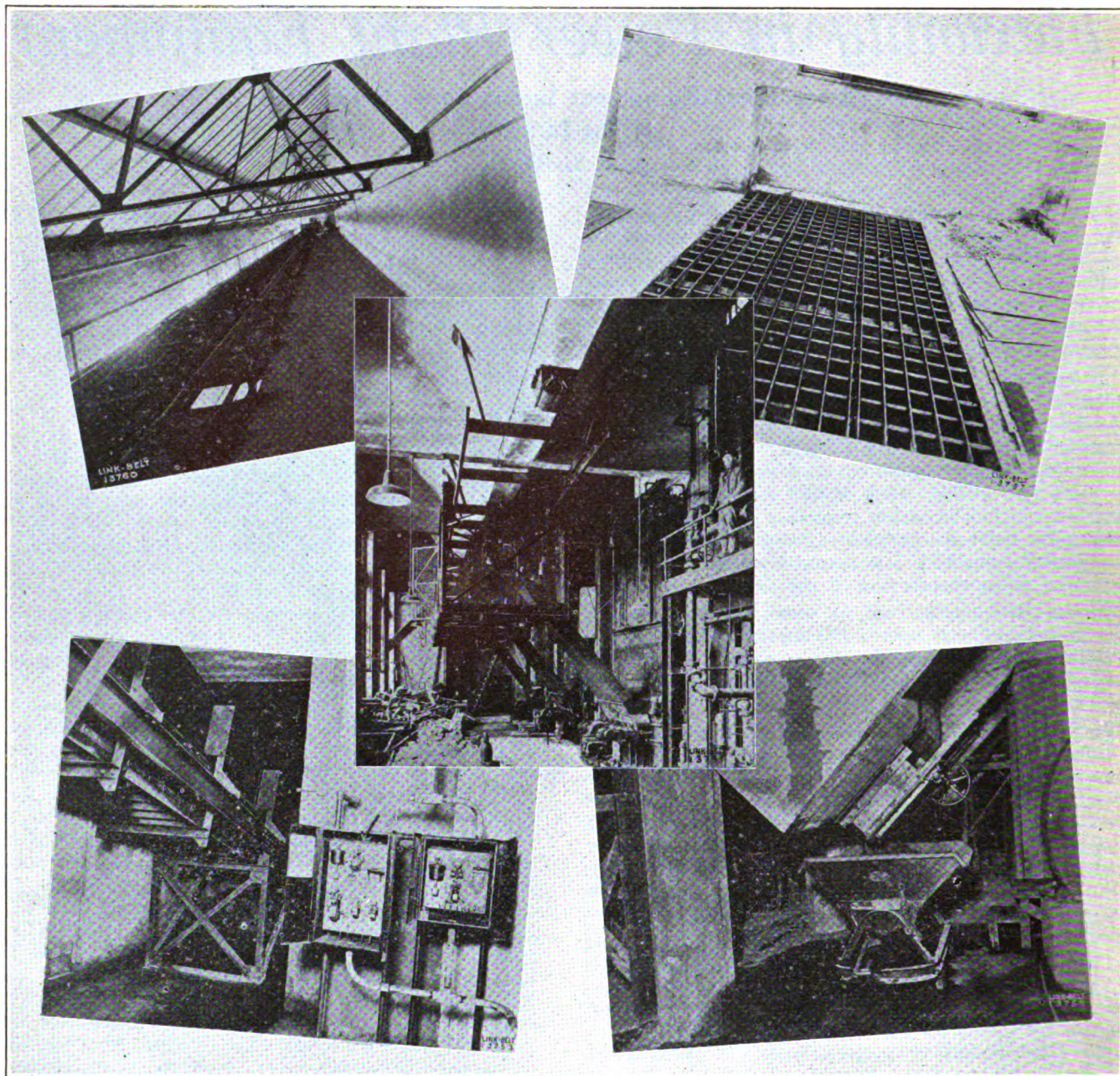
drive. A steel apron conveyor removes the coal from this hopper, for further delivery to the crusher or conveying system. This apron conveyor is shown in Fig. 1, together with the electrical control boards and on which (indicated by arrow) is mounted an automatic cut-out operated from the time limit switch located on the driving end of the pivoted bucket carrier.

Eliminating Over-time Operation.

The bulk of the coal being brought to the plant by trucks instead of railroad cars, it appeared to the engineers of the City of Milwaukee that in all probability, unless special means were provided, the carrier and coal handling system would be running idle a large percentage of the time. Allowing a coal handling system to operate 5 or 10 minutes overtime on a 50-T. supply would not amount to much in percentage of over-time run. Such an allowance made to the small $7\frac{1}{2}$ ton truck loads, however, would mean that on every load, the machinery might operate 50 per cent overtime. This overtime percentage when calculated on a yearly basis, would prove excessive in power costs. For this reason, a time limit switch was devised and operated from the drive shaft of the Peck Carrier, so that the coal handling system would operate over an interval of time sufficient to remove $7\frac{1}{2}$ tons from the receiving hopper and deliver it to the farthest section of the overhead bunker, whereupon the whole system would automatically cease operation. More briefly stated, the operator, after the truck has dumped its load, presses a push button, thus starting the coal handling system. The coal is then delivered to the overhead bunkers, after which it automatically stops and awaits the next load of coal. The device, as may be noted, consists of a worm driving a large wheel to which is attached a pin which trips open the switch which stops the conveyor during each revolution. The speed of the large wheel is geared down so that an entire $7\frac{1}{2}$ -ton truck load can be delivered to the bunkers, during a complete revolution.

From the apron conveyor the coal is discharged into a three-way spout. Here the coal (if it is not steam size) can be sent through a two-roll crusher, which crusher feeds to the lower run of the Peck Carrier. However, should the coal be of steam size it is not necessary to operate the coal crusher but can be bypassed around the mechanism and directly to the Peck Carrier. This bypass may be designated as by-pass "2". As an emergency measure, for use only in the event the conveyor is out of operation, bypass "3" is used. If, for any reason, the conveyor should be rendered inoperative, the coal being discharged from the steel pan apron feeder can be spouted in a third direction which leads to industrial cars. In the cars the coal can be wheeled to either the skip hoist or the platform elevator for delivery overhead. This is one of the ways Riverside eliminates improbable emergencies and assures itself continuity of operation.

*Engineer, Link-Belt Company, Chicago, Ill.



Upper left—A remarkable view of Peck carrier in operation at Milwaukee Pumping Station; note the length of horizontal conveyance. Upper right—A fine example of coal grating. The cross-bars prevent any long pieces of timber from passing through. Center—A typical middle-western boiler-house interior. The underfeed stokers are intermittently supplied with coal by means of the weigh hoppers shown. Lower left—Automatic breaker shown on electric control board regulates the operation of apron conveyor. Lower right—A nice installation of ash-hoppers and discharge gates.

Upper left interior view illustrates the overhead run of the Peck Carrier from which the coal is discharged to the concrete bunkers. Driven by a 10-hp. motor this conveyor operates on 167 ft. horizontal centers and 66 ft. vertical centers, the individual buckets being 24 in. by 18 in.

Large Capacity Overhead Bunkers.

The overhead bunkers are of reinforced concrete construction and have a capacity considerably in excess of that ordinarily found. This is to provide for a coal reserve, the only means Riverside has for coal storage. To prepare against fire or spontaneous combustion in this overhead storage, and to provide a means for putting such a fire out by turning the coal over, portable steel chutes were made a part of

the coal handling equipment. These chutes, can receive the coal drawn from the overhead bunkers and deliver it, directly downward, through the boiler room floor to the lower run of the conveyor, when the coal would be returned to the same bunker from whence it was drawn. Thus the stored coal can be turned over, which action in itself will put out any possible fire or eliminate the possibility of internal heat. This, in our belief, is the cheapest and most effective method of eliminating this condition. No such fire has yet occurred, nor is one expected, but the chute, supplied at small additional expense, is there ready for service, just as a fire hose or chemical extinguisher, in case of emergency.

At present, with only three of the ultimate six boilers installed, three of the overhead bunkers are

used solely for storage purposes. This stored coal, when needed, is obtained through the use of the emergency chutes.

Center figure shows the interior of the boiler room. It is apparent from this photographic reproduction that the power station is not fully completed. Indeed, at the time this picture was taken only one boiler of the three shown was in operation, the battery of the three boilers for the opposite end of the room being yet to install.

Coal Weighed by Individual Scales.

Coal drawn from the storage bunkers overhead is accurately weighed with individual scales before it is passed to the stoker magazine. Considerable thought was given to this matter by the city's engineers and it was decided that each boiler would be handled independently and that accurate records be kept of the weight of the coal consumed by each. Individual Richardson scales of 200 lb. capacity, automatic belt feed, were selected because this equipment affords accurate though automatic weight of all coal used. It is almost impossible, according to the engineers, to get men to always keep their records properly separated, as is necessary in the use of a traveling weigh larry. Through the installation of the individual scales the boiler room was almost completely automatized.

Center figure shows the manner in which these scales were individually mounted. Each is protected by a cage which prevents their being tampered with. The entire platform can be rolled to one side when the boiler chutes are being removed, or for any purpose that makes necessary the removal of the scales.

Ash Removal.

Ashes are deposited from the boilers to concrete ash pits illustrated in lower right. From these hoppers, the ashes are discharged to industrial cars in which they are carried by means of hand lift trucks to the skip hoist receiving hopper. The bucket of this skip hoist is of 30 cu. ft. capacity, the travel being 80 ft.

If for any reason the skip hoist should become inoperative, the ashes can be delivered to the overhead ash hopper by means of the pivoted bucket carrier or through the use of the platform elevator which could lift the industrial cars to the proper level for dumping, by hand, into the ash hopper. The ash storage hopper leads to the truck driveway, where upon occasion, the truck bringing the coal can be used to carry away the ashes.

Provisions for Safety.

Two elements of danger to workmen were avoided in the design of this skip hoist. One—the possibility of a man falling into the receiving hopper; the other—the hoist being put in operation while a man was in the pit doing any sort of work. The first possibility was eliminated through placing a hinged cover plate over the mouth of the hopper and extending the casing of each end of the hopper to prevent a man stumbling into it in the dark. Furthermore, when hinged cover plate over the hopper is raised the skip hoist cannot be operated until the man handling the ashes lowers that cover plate and pushes the starter button.

To guard against the skip hoist being operated while a workman might be in the pit, the skip hoist is rendered inoperative when the trap door is raised.

This trap door is the only way a workman may gain access to the pit, and the raising of this trap door throws off all electric current and renders the skip inoperative. The trap door, in itself, is a positive feature.

The upper end of the skip hoist is interesting. Considerable ingenuity was necessary when installing this skip to get it properly fitted without the necessity of cutting a truss. The chute leading from his hoist is a two-way affair, so that it is possible to chute ashes to either the carrier or the industrial cars.

Link-Belt Company of Chicago designed and manufactured the coal and ashes handling equipment described.

Mechanical Stokers

The Department of Commerce announces the following statistics on Mechanical Stokers for the month of March 1925, compiled from reports received from 13 establishments. Comparative statistics are presented by months from January, 1923, to March 1925.

STOKERS SOLD, HORSE POWER, AND KINDS OF INSTALLATION

Year and Month	Establishments reporting (No.)	Stokers Sold		Installed Fire-tube Boilers		Under Water-tube Boilers	
		No.	H.P.	No.	H.P.	No.	H.P.
1925							
March	13	131	71,099	17	2,446	114	68,653
February	13	135	46,298	28	4,905	107	41,393
January	13	57	27,871	4	870	53	27,001
1924							
December	13	91	31,732	18	1,788	73	29,944
November	13	106	37,167	11	1,675	95	35,492
October	13	104	58,565	7	1,702	97	56,863
September	13	73	25,988	27	6,646	46	19,342
August	13	94	41,931	17	2,486	77	39,445
July	15	115	37,759	14	1,660	101	36,099
June	15	102	35,549	19	2,724	83	32,825
May	15	64	34,447	3	550	61	33,897
April	15	89	47,939	15	1,970	74	45,969
March	15	89	34,597	12	1,625	77	32,972
February	15	110	62,113	11	1,525	99	60,588
January	15	91	66,492	7	1,044	84	65,448
1923							
December	15	73	32,517	17	2,820	56	29,697
November	15	50	16,241	10	1,300	40	14,941
October	15	88	32,576	14	2,330	74	30,246
September	15	99	60,486	16	2,754	83	57,732
August	15	135	71,693	18	2,624	117	69,069
July	15	129	52,518	21	3,454	108	49,064
June	15	135	59,719	6	804	129	58,915
May	15	194	100,513	14	1,915	180	98,598
April	15	167	85,339	14	2,000	153	83,339
March	15	120	68,955	9	1,259	111	67,696
February	15	129	66,619	9	1,172	120	65,447
January	15	145	83,270	29	3,400	116	79,870

The demand for automatic control operation of water gas apparatus is being maintained. The U. G. I. Contracting Company, of Philadelphia, has lately been called upon to furnish and install the U. G. I. automatic controls at the plant of the Public Service Electric & Gas Company at its Camden, N. J. plant. Also at the plant of the Connecticut Power Company at New London, as well as on the blue gas apparatus installed at the Erie, Pa. plant of the Perry Iron Works.

OBITUARY

Mr. Otto Schaumberg, noted engineer, died suddenly, following an operation, April 19th. Formerly associated in an engineering capacity with the Westinghouse Elec. & Mfg. Co., later in the Sales Department of that company. Mr. Schaumberg, at the time of his death, represented the Treadwell Engineering Co., as sales manager of the Pittsburgh territory.

Expansion Steam Bends

A Series of Investigations Which Develops Formulae
Suitable for High Super Heats

By P. M. GALLO,* M.E.

SINCE higher steam pressures and higher degrees of super-heat are coming into use, it is necessary to be able to investigate expansion bends in all phases. Following are formulas theoretically deprived from the elastic theory and fully substantiated by the exhaustive tests on all sizes and kinds of expansion bends made by the Crane Co. of Chicago. By means of these formulas the fibre stress, the expansion and the pressure on the anchors due to deformation, can be easily determined for any kind of bend, simple or compound.

Notation Used.

l_b =height of double off-set—straight yoke expansion bend.

P =force, pounds, exerted on steam line and anchors due to deformation of expansion bend.

d =outside diameter of pipe, inches.

R =radius of bend, inches.

F =deformation or expansion, inches.

I =moment of inertia of pipe used in bend.

E =modulus of elasticity= 20×10^6 for pipe steel.

l =linear length of pipe in bend, inches.

S =extreme fibre stress, pounds per square inch.

P_s =steam pressure, pounds per square inch.

t_p =thickness of pipe wall, inches.

S_p =longitudinal fibre stress in pipe due to steam pressure.

S_t =transverse fibre stress in pipe due to steam pressure.

l_s =straight pipe length—inches—in double offset straight yoke expansion bend.

S_m =maximum total tensile stress in pipe, pounds per square inch.

A =sectional area of pipe, inside, square inches.

F_s =half the expansion value due to " l_s " in the double offset straight yoke bend.

K =lateral deflection of straight pipe " l_s " in double offset straight yoke bend.

A_1 =area of metal in cross section of pipe, square inches.

Figs. 1 and 2 will assist in the application of the symbols.

$$P = \frac{2IS}{dR} = \frac{FEI}{IR^2} \quad \text{Eq. 1.}$$

$$F = \frac{PIR^2}{EI} = \frac{2SIR}{dE} \quad \text{Eq. 2.}$$

*Pittsburgh, Pa.

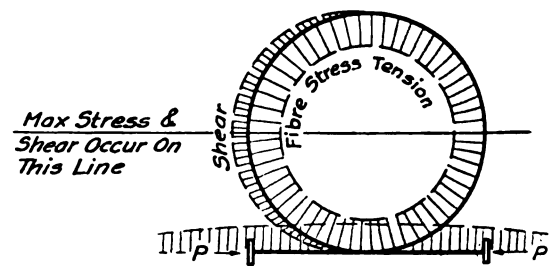
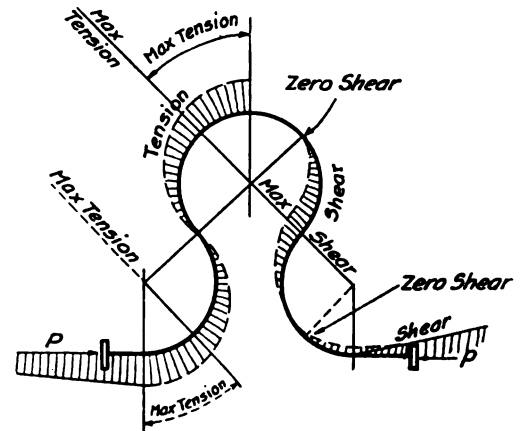
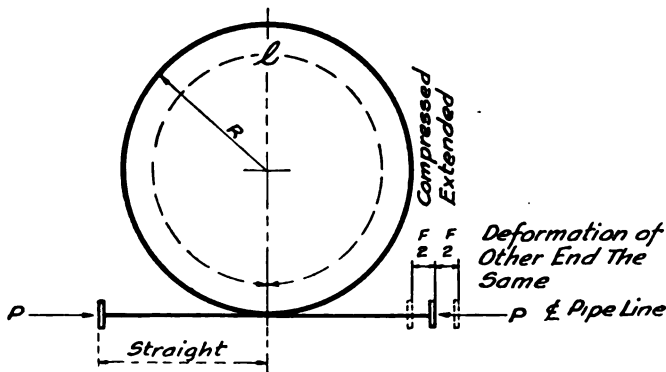
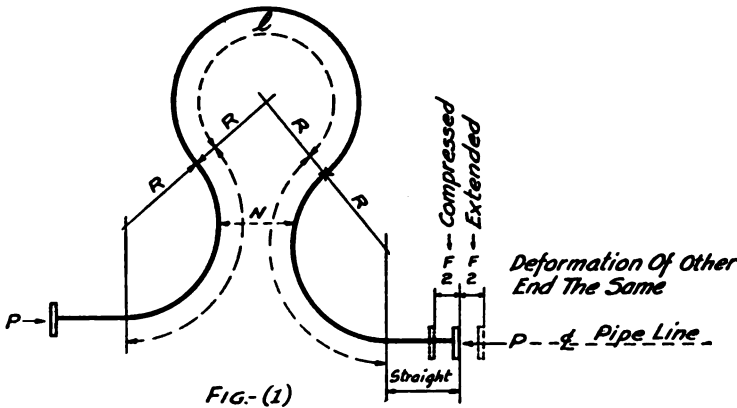


FIG. 1.—Double offset expansion bend, all radii equal. FIG. 2.—Loop expansion bend. FIG. 1a.—Double offset bends, distribution of stresses for Figs. 1, 3, 4, 5. FIG. 2a.—Loop bend, stress distribution.

$$S = \frac{FED}{2lR} = \frac{dRP}{2l} \quad \text{Eq. 3.}$$

$$l = \frac{FED}{2SR} \quad \text{Eq. 4.}$$

$$l = \frac{FE}{10S} \text{ when } R = 5D \quad \text{Eq. 4a.}$$

This concludes the general equations.

Equations 1 and 2 are the fundamental equations of a helical spring in torsion. Any curve of an expansion bend can be considered as part of a helical spring, and what is true of the whole spring must be true of any of its parts.

By specializing these formulas for particular bends most used, calculations can be considerably simplified. Take the double offset bend Fig. 1, and standardize by making all radii equal and the neck N equal to half the radius or $R \div 2$, then

$$P = \frac{FEI}{9.8655 R^3} \quad \text{Eq. 5.}$$

$$F = \frac{19.731 SR^2}{dE} \quad \text{Eq. 6.}$$

$$S = \frac{FE d}{19.731 R^2} \quad \text{Eq. 7.}$$

$$R = \sqrt{\frac{FED}{19.731 S}} \quad \text{Eq. 8.}$$

$$l = 9.8655R; \text{ contained in arcs, add straight for ends.} \quad \text{Eq. 8a.}$$

Similarly for the loop bend—Fig. 2.

$$P = \frac{FEI}{2\pi R^3} \quad \text{Eq. 9.}$$

$$F = \frac{4\pi SR^2}{dE} \quad \text{Eq. 10.}$$

$$S = \frac{FE d}{4\pi R^2} \quad \text{Eq. 11.}$$

$$R = \sqrt{\frac{FEd}{4\pi S}} \quad \text{Eq. 12.}$$

$$l = 2\pi R; \text{ contained in arc, add straight for ends.} \quad \text{Eq. 12a.}$$

Bends figures 1 and 2 cover the majority of case. In the double offset bend if possible the radii should all be equal as that is the most efficient and economical proportion. If the radii cannot be made equal, proceed as follows:

Figs. 3, 4 and 5 show double offset bends of variable radii. In Fig. 3 radius $R1=R1$, and are smaller than R which is the larger. In Fig. 4 R and R are equal and $R1$, the loop radius, is smaller. In Fig. 5 R is the larger radius, $R1$ smaller, and $R2$ smaller than $R1$. In any of these cases determine the value of P for the maximum fibre stress in curve of radius R , or the largest curve in the series. Then by Equation 2 determine the value of F for the successive arcs, and the summation of these values will

give the total value of F or the expansion cared for. This holds true for any number of arcs of various radii in series. Always use the length of arc subtended by the swing of a given radius in conjunction with this radius, to determine F , S and P .

Another type of expansion bend is the double offset straight yoke type. This is little used because its properties are not known, but it is very convenient where lateral room does not permit of the other types easily. This type is shown in Fig. 6. The four radii are equal. The straight part " l ," is between points of tangency " a ". The elastic curve for this straight part " l ," is a perfect circle since the fibre stress S is the same for its full length. The deformation or expansion for the two offset bends is calculated by Equation 2. To this must be added the additional expansion value due to the curvature of " l ,". This additional expansion is given by the following equations.

$$F_s = l_h \tan \frac{57.295 Sl_s}{dE}; \text{ for one end} \quad \text{Eq. 13.}$$

$$\text{Total expansion} = 2F_s = 2l_h \tan \frac{57.295 Sl_s}{dE} \quad \text{Eq. 14.}$$

Total expansion for double offset straight yoke bend = F (calculated by Eq. 6) + $2F_s$ (calculated above. Note the value of " S " must be the same in both cases. The lateral deflection of " l ," is

$$K = d \frac{E-S}{2S} \left(1 - \cos \frac{57.295 Sl_s}{dE}\right) \quad \text{Eq. 15.}$$

In designing any kind of expansion bend the maximum value of S should be fixed on first. Since the elastic limit of pipe steel is 33,000 lbs. it is good practice to fix the value of S (due to bending only) at 20,000 pounds per sq. in. To this must be added the value of S_p ,

$$S_p = \frac{A P_s}{A_i} \quad \text{Eq. 16.}$$

Also the transverse stress (which is usually small)

$$S_k = \frac{P_s(d-2tp)}{2tp} \quad \text{Eq. 17.}$$

$$\text{Total maximum tensile stress in the metal is then:} \quad \sqrt{(S + S_p)^2 + S_k^2} = S_m \quad \text{Eq. 18.}$$

In the loop bend the maximum fibre stress and shear occur at the same point, hence the value of " S " may have to be taken lower than 20,000 pounds per square inch, inspection only, will decide this.

Since F is the deformation from the neutral position of the bends, then by spreading the bends an amount equal to " F " when installing same, or when line is cold, then the total expansion cared for by the bends is TF . In other words the bends will care for expansion of twice the amount calculated by Equations 2, 6, 10 and 14. The magnitude of the stresses is the same in either extreme position except they change sign, tensile changes to compressive, and compressive changes to tensile.

The variation of stresses in the various types of bends is shown in Figs. 1a, 2a, 3a, 4a, 5a and 6a.

Pipes up to 12-inch can be obtained in double lengths, nominally 40 feet. But in special cases they can be ob-

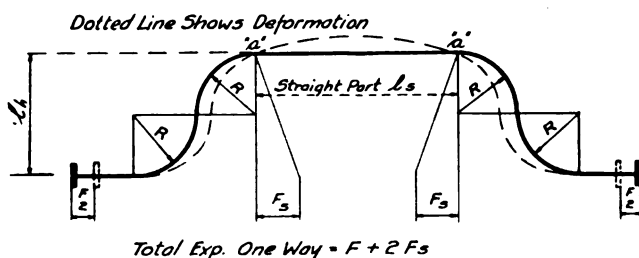
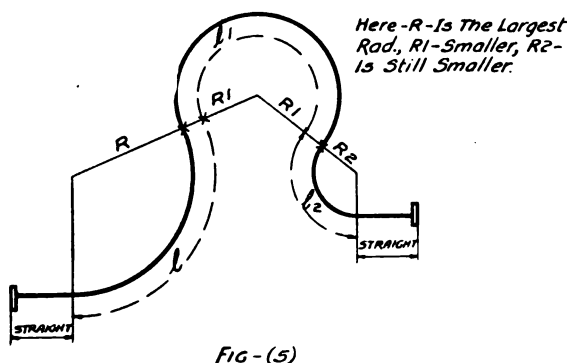
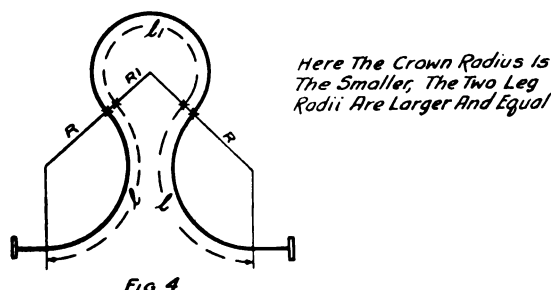
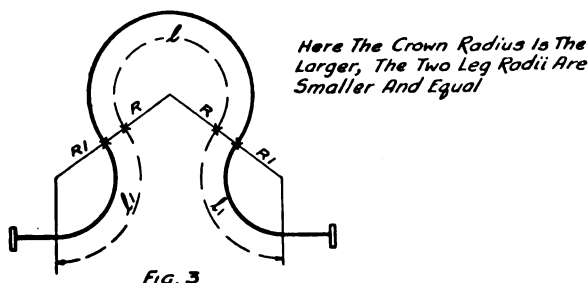


FIG. 3.—Double offset expansion bend, two different radii, crown radius largest. FIG. 4.—Double offset expansion bend, two different radii, crown radius smallest. FIG. 5.—Double offset expansion bend, three different radii, crown radius intermediate. FIG. 6.—Double offset straight yoke expansion bend, all radii equal.

tained 42 feet long as second runs average from 42 to 44 feet.

The largest size pipe out of which a single piece standardized double offset bend can be made is determined as follows: All radii being equal and the neck equal to $R \div 2$, the total length of curved pipe or pipe in arcs is

$9.8655R$. In any pipe bend the radius of curvature should not be less than five diameters of the pipe. Therefore if " d_n " is the nominal diameter of pipe the radius equals $5d_n = R$, the length of pipe in bend proper is then $5d_n \times 9.8655$ in inches when d_n is in inches. To this must be added the straight ends or tangent parts. These tangent parts must be long enough to admit making the bend. For Van Stone flanges High Hub type, this is usually not less than equal to d_n . It can be made shorter but is not advisable. For screwed and welded flanges this tangent length is from one-half to two-thirds of " d_n ." Take therefore a pipe 42 feet long face to face of laps after flanging, which means the pipe must be 42 feet 42 inches to 42 feet 6 inches long before van stoning. Allow two feet for the tangent parts collectively, then 42 feet 0 inches less 2 feet 0 inches equals 40 feet for the bend proper. Then $5d_n \times 9.8655 = 40 \times 12$, $d_n = 9.7$ inches+, say a 10-in. pipe, making the radius R —one inch less than five diameters will give $11\frac{3}{8}$ inches for each of the tangent ends.

The loop bend can be made in one single piece up to 12-inch pipe.

Larger expansion bends or bends of larger pipe require intermediate joints, flanged or welded. Whether these welded joints are made in the shop or in the field depends on the size of the bend, the largest piece that can be shipped must be within the clearance allowance on railroads. When intermediate joints are used, the question arises, should these joints be at the points of inflection, or can they be anywhere. A few 18-inch pipe expansion bends came to my notice lately, that the longest pipe length obtainable would not bridge from point of inflection to point of inflection around the crown. Although there is always a controversy as to the location of the joints, it is invariably overlooked that the flanges connecting to the steam line or main are subject to a bending moment equal to the developed resisting moment of the adjacent arc, and when all radii are equal or the loop bend is used, this developed resisting moment is the maximum in the bend. Yet no trouble has been experienced from these joints, nor has anybody yet complained about them. This would prove conclusively that flanged joints will safely take any bending stress in loops or double offset expansion bends properly designed.

In order to make this reasoning more convincing, an investigation of flanged joints under bending stress, will be made.

(To be continued.)

Will Chippers Wear Goggles?

(Continued from page 204.)

This procedure made each one of those men feel that the safety man had a real personal interest in his welfare; and believe me it worked as evidenced by the fact that during the year 1924 we have not had a single lost time accident of any kind from that department.

Another method that we have found to bring results and incidentally save money is that when we find a man engaged in chipping who has defective eyesight, we stand the expense of making corrective lenses fitted to goggles for his use. This, also, has a further psychological effect, in that employees in other departments, hearing of what the company is doing in the chipping room, get the idea that the company is on the square in its safety work. Confidence in the company's safety methods and ideas is fundamental to good results.

—Labor and Industry, Pa.

Pipe Companies Consolidate

Pittsburgh Piping and Equipment Co. and American Foundry and Construction Co. announce their consolidation, the object of which is to strengthen their position as the leading fabricators of power piping in the country. The officials of the former company will be connected with the new organization. The combined business will be operated by the Pittsburgh Piping & Equipment Company.

The Pittsburgh Piping & Equipment Company will occupy their new plant located in Pittsburgh and the fabrication of all materials will be carried on in this plant.

The officials of the company will be as follows: President and general manager, George H. Danner; vice-president, Morgan B. Schiller; vice-president and treasurer, Chas. R. Rall; secretary, W. R. Neely; general manager of sales, Robert Whyte; assistant secretary, Louis K. Hamilton; manager of purchases, Karl F. Tiegel.

The present district offices of this company will be maintained: Pittsburgh Piping & Equipment Company, 35th and Charlotte Streets, Pittsburgh, Pa.; A. T. Brodie, Ulmer Building, Cleveland, O.; D. G. Sinclair, 220 Broadway, New York City; Berford Brittain, Peoples Gas Building, Chicago, Ill.; Geo. W. Smith, Traction Terminal Building, Indianapolis, Ind.; Oliver B. Lyman, Call Building, San Francisco, Cal. When you think of piping, think of Pittsburgh Piping.

New Industrial Crawling Tractor Crane

A locomotive crane is not a tool adapted for use in a few industries. It is a labor-saving device which is far more versatile and which has a much greater field of usefulness than any other machine whose function is handling material. It is not only useful but it has become practically a necessity on railroads, in ship building plants, in the iron and steel industries, in lumbering operations, in coal yards, on contracting work, in sugar manufacturing, in foundries, on docks and in practically all manufacturing plants.

Crawling tractor cranes have been developed to extend the usefulness of the locomotive crane beyond the limitation of rails and now several manufacturers of material-handling equipment have already entered this field, among them the Industrial Works, Bay City, Mich., who for the past 52 years have been building locomotive cranes and crane equipment.

They have just recently announced a new and greatly improved 10-ton crawling tractor crane. This crawler crane, known as their type DC, is very similar in outward appearance to the former types of tractor cranes built by that company, but its design embodies a host of new engineering features such as split gears for propelling, increased speeds, double clutch mechanism, unusually long tractor belts, independent functions, etc., which, it is claimed, make that machine the fastest, simplest, sturdiest and most rugged type yet produced, and the most economical to operate.

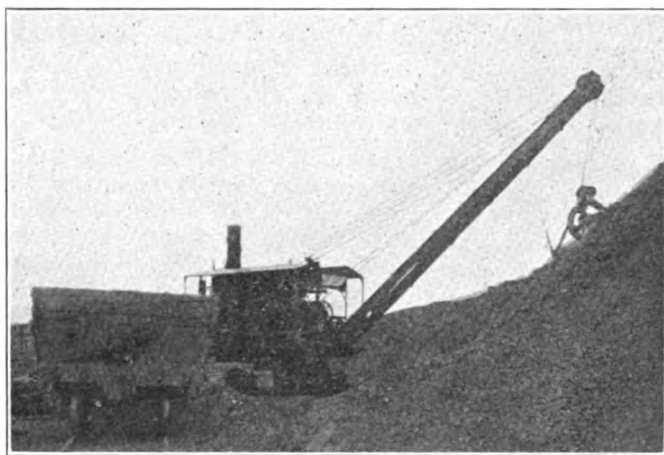
The most important of all the new features is the system of split gears by which each tractor belt is separately controlled. Two concentric vertical propelling shafts at the axis of revolution lead two independent but concentric trains of spur and bevel gears, each operating one tractor belt. Each belt is directly controlled by two powerful friction clutches and brakes in the revolving upperworks, which gives

absolutely independent, definite and easy control over each belt while propelling. This is an all gear drive from engine to sprockets with no chains in the mechanism at all. The Industrial type DC is said to be the only crawler crane which steers and propels by friction clutches. It is also said to be the only crane which has a friction clutch and band brake for each tractor belt. These features make maneuvering in close quarters comparatively simple.

All speeds of the motor operated crane have been increased 25 per cent which provides ample speed for the fastest possible handling of all materials. This new feature should make for great savings in time and corresponding savings in money.

The double clutch mechanism by which the two slewing band clutches are operated by one lever makes for very simple slewing. The direction of slewing is changed at will by the movement of the slewing double clutch lever. No reversal of the engine is necessary.

The crawling tractor belts are of ample length to give plenty of stability when lifting over either end, on any kind of ground.



The center distance between the two end sprockets on the "DC" is 10 ft., one of the longest on the market today, giving ample stability and support for a large range of operation.

All functions of this crane are absolutely independent of each other, which means greater certainty of operation. Separate levers actuating each function are conveniently placed on the operator's platform in the revolving upperworks. Different combinations of these independent functions may be utilized at one time to great advantage.

This crane can be equipped to operate with a steam engine, electric motor, gasoline motor or fuel oil engine of the Diesel type to suit any operating conditions known today. It is extremely versatile, operating with clamshell or dragline bucket, electromagnet, hook and block or grapple. It is readily convertible into a shovel or a pile driver. Any equipment that operates on a boom can be applied.

The utmost care has been used to combine the necessary strength with the light weight essential to a tractor crane, and convenience in operation and maintenance have been provided to the highest possible degree. The makers are confident that this new improved crane will continue to supply a demand for a general utility crane of small capacity sturdily built. It has already found a ready market in practically all fields of industry.

WITH THE EQUIPMENT MANUFACTURERS

New Way of Starting Small D.C. Motors

The Lehigh Valley Coal Company recently adopted a novel means of starting the small direct current motors used for driving portable mine pumps. The customary practice of throwing these motors directly on the line usually causes much spitting and arcing at the brushes.

To eliminate this, about 15 protective panels, of the General Electric CR-3171-6 type, were purchased and rewired as follows: One contactor is used to open and close the shunt field, the other to open and close the positive line to the motor. A snap switch is used to provide under-voltage release, which when closed, completes the control circuit of the shunt field contactor. The interlock on this contactor completes the control circuit for the line contactor. The short time interval between the closing of the shunt field and the motor line by this method of wiring allows the shunt field to build up and eliminates most of the sparking when the motor is thrown on the line.

A resistor tube is connected across the contact tips of the shunt field contactor. This tube is shorted while the motor is running but, when the motor stops, allows a small amount of current to flow through the shunt field, keeping the motor dry. The slight heating of the resistor tube prevents the accumulation of moisture inside the enclosing case when the motor is not running.

Dolly Truck Has Varied Uses

To save time, labor and merchandise — that's the mission of the New Marion Dolly Trucks, manufactured by the Marion Tool Works, Inc., Marion, Indiana. They incorporate many exclusive advantages in design and construction never before available in Dollies. They are light enough to be moved anywhere, but sturdy enough to last for years. Solid metal construction throughout — Marion certified malleable frame, steel axles and wheels with roller bearings.

The many valuable uses of Marion Dollies make an interesting story. They eliminate loss of time and material in handling large rolls, heavy crates, barrels, casks, packages, boxes, etc. They are built low to the floor (preventing jarring) and have no sharp edges (preventing damage to merchandise). Holes are provided for attaching any special skids, platforms or bodies the user may desire.

Marion Dollies are particularly easy to load and unload because of the handy skid projections on each side. One man can handle heavy loads because the wheels lock sideways while being loaded, so that the truck "stays put" and won't drawl or creep away from you. Then when loaded, the truck can be easily pushed anywhere desired, as the wheels run without friction and those on the center axle are larger than on the ends, permitting tilting and easy guiding. One man has pushed a two-ton load over a concrete floor, a record performance.

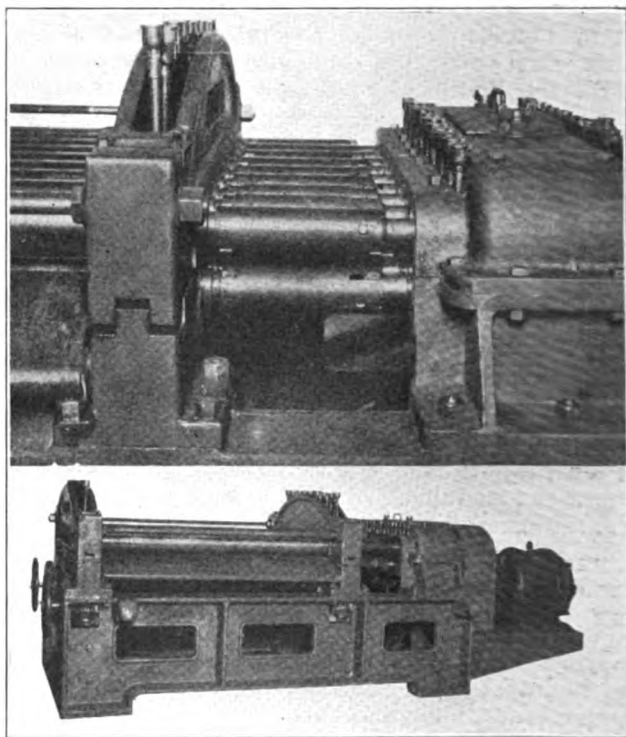
Marion Dolly Trucks are made in two sizes — 24-inch and 32-inch. An interesting catalog will be sent free upon request — along with a special 10-day free trial offer to all readers who will write to the manufacturer and mention this publication.

New Roller Leveller Developed

The Aetna Foundry & Machine Co., of Warren, Ohio, have designed and are introducing a new roller leveller for use in full finish sheet mills and also for use directly on jobbing mills where they level sheets directly off of the mill.

Two views are shown in the accompanying figure.

This leveller is built in 48-in., 54-in. and 60-in. size, this being the width of the rolls between housings. The leveller has seventeen rolls $4\frac{3}{8}$ in. in



diameter. Rolls can be made of any steel or hardness specified. All rolls are driven by a newly developed universal coupling from a gear box running in oil. The reduction gears running in oil insure smooth operation and long life of mechanical parts. The universal coupling is of ball and socket type and is made in such a way as to insure against any vibration and back lash or looseness at any time during the life of the machine regardless of whether the machine is levelling 31 gauge or 10 gauge. This positive coupling is very necessary in full finished sheets in order to overcome the common tendency of levellers to make chatter marks on the surface of the sheets. The leveller is portable as the machine is built on one common base on which are cast lifting lugs so that the leveller can be handled from one plant to another

with a crane. Motor bracket is attached to this common base.

A machine has been designed along similar lines for use in light plate mills and is made up to 75 in. wide in order to take care of the requirements on continuous mills.

Non-Sticking Valves for Caustic Solutions

The difficulties of stopcocks sticking when used in systems handling caustic solutions has been solved by the General Electric Company by the use of genelite as a facing for the rotating part of the valve. Among the properties of the material are that it never seizes or flows and that it is self-lubricating to a certain extent.

Considerable trouble was experienced with valves in the oxygen and hydrogen producing plant of the company. Valves stuck, and needed to be disassembled and sometimes destroyed after they had been used in caustic systems. Valves with genelite facings were found to operate freely after 18 months of service. Such units can be used with practically any solution that will not attack bronze.

Genelite is a synthetic bronze, having uniformly distributed throughout its mass approximately 40 per cent by volume of very finely divided graphite. It was developed in the research laboratory of the General Electric Company a few years ago as an improved bearing alloy. Although the material has the appearance of bronze, it is machined with difficulty; it can, however, be ground easily. High pressure and heat are used in molding it.

Speed Reducing Gears for Motor Drives

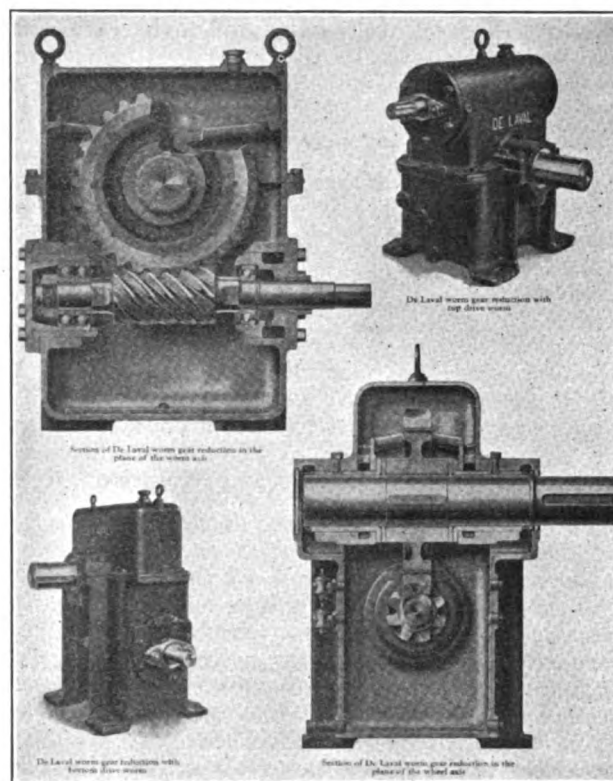
Electric motor drive has now come to be the rule rather than the exception. Individual motor drive eliminates overhead shafting and thereby improves lighting, and permits better crane facilities. It also saves floor space and permits of placing machines to suit convenience or efficiency in production, rather than with reference to existing shafting.

Only a few kinds of machinery, however, run at speeds to which electric motors are conformable. A wide range of speeds, varying by small steps, is obtainable with direct current motors, but with alternating current motors only a few fixed speeds are available, and in any case the speeds of commercial motors are generally much higher than those of the driven machinery. Moreover, slow speed motors cost more, occupy more space, and are less efficient than high speed motors. High speed alternating current motors also have better power factor characteristics than do slow speed motors. These considerations have led to the use of a wide variety of speed transmission devices, such as belts and pulleys, chains and sprockets, and toothed gearing, and more recently, various compact forms of gear speed reducers, including spur gears and worm gears.

In order to obtain any considerable speed reduction, involving a multiplicity of gears, shafts and bearings. For the sake of compactness, some of the gears may be of the internal type or of the planetary type. The crowding together of gears, however, implies short bearings, or even overhung bearings, and consequent poor alignment after slight wear has taken place. While the efficiency of spur gears may be fairly high at the beginning, it gradually decreases

with use, as the teeth do not wear in such a way as to maintain the correct contour. After the teeth have become worn, the driving force is transmitted by a series of blows, which increase in force until the teeth may strip. The latter drawback can be overcome by the use of helical or twisted gears, but in the endeavor to secure compactness, sufficient width of face is generally not provided to insure continuous contact between teeth at the pitch circle. The spur gear type of reducer usually occupies more space than the motor itself and involves placing the motor that much farther away from the driven machine.

The worm and worm wheel type of reduction gear, while widely used, has in the past suffered from incorrect design, and from being built in ordinary gear manufacturing establishments having neither exceptional skill nor special equipment. The tooth shape has been that used in spur gear practice, without consideration being given to interference, resulting in a small effective area of tooth contact and



relatively low load capacity, and further, while the worm threads are sometimes hardened and ground, the materials used have not generally been those best suited for the purpose, with the result that such gears could be used successfully only where the pitch line velocity was low and the duty light and intermittent, and where efficiency was of little consequence.

However, worm gears combining noiseless running, high efficiency, compact construction and reliability under the most adverse conditions have lately been developed, particularly in Europe, where they are extensively used in industrial and automotive applications. In America, high class worm gears have been applied principally in the automotive field, but the De Laval Steam Turbine Co., of Trenton, N. J., has developed a line of worm gear reductions which are applicable to motors and turbines driving such machinery as rotary kilns and coolers, tumbling barrels, agitators, mixers, dryers, mills,

calenders, paper machinery, machine tools, stokers, cooling tables, transfer rolls, door lifts, fans, elevators and conveyors of all types.

The design of this gearing has been based upon a careful study of the underlying engineering principles, and the gearing is produced by special equipment. It differs from the ordinary worm gearing in the tooth shape used, in the materials employed, in the treatment of the materials, and in the manufacturing methods and shop control. The tooth shape is such as to combine a minimum of sliding and a maximum of rolling action between the worm and the gear, and at the same time to realize continuously the greatest area of contact. Undercutting of the teeth is entirely avoided, as the included angle of the tooth is approximately 60° , as compared with about 30° as found in older types of gears. As the pressure line normal to the face of the tooth at the pitch circle falls within the base of the tooth, failure can take place only by crushing, rather than by bending. In ordinary spur gears the projection of this line falls outside the base of the tooth, and such teeth therefore often break off. In the De Laval worm gear, three or more teeth are always in contact, giving exceptionally high load capacity for the size and weight, and suiting the gear for heavy duty service.

Owing to the fact that three or more teeth are always in contact there is a smooth flow of power, resulting not only in absence of vibration and noise, but also improving the quality of the work done by the driven machine and prolonging the life of connected machinery, especially of gearing and bearings. This smooth flow of power also permits of increased production, since the machinery can be speeded up, which is not possible with certain other types of reduction, due to intermittent tooth contact in spur gears, or to the tendency of chains to whip or to climb on the sprockets, or to set up vibration, etc.

The reduction is completely enclosed in a casing, which keeps out dust and moisture. The casing is split horizontally in the plane of the center line of the wheel shaft, the lower half is supported by four substantial feet designed to permit air circulation underneath, this giving additional radiating surface. A large oil reservoir with baffles on the bottom serves to settle out foreign matter from the oil. The wheel shaft is carried on plain bronze bearings, so split as to be easily removable without disturbing the wheel shaft or the couplings. The side thrust of the wheel is carried by a hardened, ground and polished steel plate, which bears against the bronze face of the wheel shaft bearing. The worm may be located either above or below the wheel and is mounted on ball bearings, the one at the rear of the worm being of the double type and designed to carry the combined radial and thrust load, regardless of the direction of rotation of the worm. The inner races are pressed on the shaft and the outer races are clamped both radially and axially, adjusting and locating the worm in the case. The bearing at the forward end of the worm is of the radial type, the inner race of which is pressed on the worm shaft, while the outer race has clearance axially, permitting the bearing to adjust itself to the linear expansion of the shaft. This outer race creeps slowly, which distributes the wear over the race way. The bearings are carried in separate housings so that the case itself is not subject to wear. The worm and wheel and the bearings are lubricated by a splash

system, the oil thrown from the bearing being caught in troughs cast on the casing wall and thereby led to the bearings.

The worm is made from a low carbon alloy steel forging, which is carburized and heat treated after the threads are cut, to obtain a hard surface which will resist wear, and a tough, ductile core which will withstand shock. The heat treatment is carried out in an electric furnace of which the temperatures are automatically maintained within close limits. The ends of the worm shaft are drawn to remove brittleness and to insure uniform decrease in hardness from the worm threads to the shaft ends.

The wheels are made from a special composition of phosphor bronze which gives a low coefficient of friction and possesses toughness and high tensile strength. They are chill cast in dry sand moulds to obtain the maximum hardness, the pouring temperatures being carefully watched by means of electrical pyrometers. For larger sizes the rims only are made of bronze and are shrunk on solid cast iron centers to which they are secured by threaded keys riveted in place. The worm gear teeth are generated by means of hobs which are fed in axially, tangentially to the gear, this method being used because it gives the greatest possible area of contact and the best tooth shape. To insure a true pitch line the gear wheel is mounted on its own shaft and hobbled on its own bearings, eliminating inaccuracies often found in gears which are pressed on after generation.

De Laval worm reduction gears are made for transmission ratios of approximately 4 to 1 up to 100 to 1 in one step, and for any higher ratio with double reductions. Power is delivered from a worm reduction gear at right angles to the motor shaft, thus keeping the motor out of the way and often permitting of closer arrangement of machinery without sacrifice of aisle space. The wheel shaft may be extended to the right or left in both directions. Frames arranged for vertical shaft drive are also supplied. Flexible couplings of the pin and rubber bushing type are used to connect the worm shaft to the driving machine and the wheel shaft to the driven machine.

The Hoskins Manufacturing Company, now using two electric induction furnaces in the production of chromel and similar alloys, recently ordered a third electric unit for installation with the others in the Hoskins plant in Detroit. These furnaces have been found valuable in working to the close analysis necessary in such manufacture, and the Hoskins Manufacturing Company has obtained excellent results with the existing installation in producing metals of extreme uniformity with every heat.

The two original furnaces are of General Electric manufacture and the third, now on order with the General Electric Company, will be of the latest type with the winding located above the bath and cooled by air blast. The furnace will be tilted on trunions by a handwheel in the usual manner.

The new unit will have a holding capacity of 650 pounds of metal, and each pour will be about 400 pounds. It will be rated 100 kilowatts and will operate directly from the city power lines through a single-phase transformer which will step down the voltage to 40 volts, 60 cycles. Power regulation will be obtained by means of taps in the transformer and an induction regulator.

TRADE NOTES AND PUBLICATIONS

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., have recently issued their Bulletin No. 102-A.

The entire booklet of 16 pages is devoted to illustrations of the detail parts of their Vertical Long Cross-head Blowing Engines. The adequate cut-captions make the bulletin invaluable for the purpose of spare part re-orders.

The Costello Engineering Company has been recently incorporated. It has purchased from the Tate-Jones Company the Costello Patents on Sheet and Tin Mill furnaces, as well as all drawings and patterns of both open and box annealing furnaces. It is prepared to build furnaces under these patents and render engineering service in connection with Sheet and Tin Mill construction.

Mr. T. J. Costello will continue his connection with the company as vice president.

Strickland Kneass, Jr., has been appointed General Manager and Chief Engineer. Mr. Kneass was previously steam engineer with the Youngstown Sheet and Tube Company.

The other officers of the company are: James L. Stuart, Pittsburgh, president; Mr. J. M. Tate, Jr., vice president and treasurer.

The Costello Engineering Company has temporary offices at Leetsdale, Pa., and will later take up its quarters in the Oliver Building, Pittsburgh, Pa.

Mr. H. E. Neubauer, formerly assistant chief engineer of the Buffalo Foundry & Machine Co., later vice president of O. S. Sleeper Co., Inc., has become associated with the Chemical & Vacuum Machinery Co., Inc., as chief engineer.

C. W. Ross, formerly with the Beaumont Co., is now manager of the Philadelphia office of The C. O. Bartlett & Snow Co., designers and builders of materials, handling and processing equipment, Cleveland. The Philadelphia office is located at 807 Schaff Building.

New Edition Metal Statistics

The new eighteenth edition of the year book, Metal Statistics 1925, is now ready for distribution.

Metal Statistics contains all the useful and authoritative iron, steel and metal statistics relating to production, consumption, imports, exports, stocks and various other data that is indispensable to those who desire a complete and accurate knowledge of important market and trade information. Those who are interested in interpreting various statistical movements of the iron, steel and metal market will find Metal Statistics a very valuable reference book.

Producers and consumers, buyers and sellers of metals, iron and steel and their interrelated products have found Metal Statistics so useful and valuable that they have characterized the "little red book" as the standard statistical reference work of the iron, steel and metal industries.

While previous editions have been regarded as complete, Metal Statistics 1925 contains many new tables and statistics, and covers even a wider scope than any of the previous editions. The statistical information answers every practical requirement. \$1.00 per copy. Orders should be sent to The American Metal Market Co., New York City.

Current Literature on Ferrous Metallurgy

(Continued from page 207.)

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Le facteur de puissance en électrochimie et électrometallurgie. M. Bunet. *J. du Four Electrique*, v. 34, Feb. 1, 1925, p. 17-19.

Foundry planning for economical production. Evan J. Ross. *Foundry Trade J.*, v. 31, Mar. 26, 1925, p. 259-262.

Serial.

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From *Queen's Quarterly*.

Gaseous fuels for furnace heating. R. V. Wheeler. *Iron and Coal Trades Rev.*, v. 110, Mar. 27, 1925, p. 503-504.

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Iron cementing compositions. *Foundry Trade J.*, v. 31, Mar. 26, 1925, p. 273.

From *Chemical Trade Journal*.

Japanning oven temperature automatically controlled. C. S. Wadhams. *Metal Ind.*, v. 23, p. 102.

Large uses of steel in small ways; electric bells. *Iron Trade*, v. 76, Apr. 2, 1925, p. 884.

Modern tendencies in Eastern steel markets. Sir Edgar R. Jones. *Iron and Coal Trades Rev.*, v. 110, Apr. 3, 1925, p. 541-542.

Net profits from modern equipment; lowering production cost to get lower selling price and, in turn, increased consumption and better net profits; some examples of progressive policy. Frank A. Scott. *Iron Age*, v. 115, Apr. 2, 1925, p. 957-961.

(To be Continued.)



George Mesta Dies in New York

President George Mesta of the Mesta Machine Company, Mesta, Pa., died in the Ritz-Carlton Hotel, New York City, Wednesday, April 22. Death was due to heart disease.

Mr. Mesta was a graduate of W. U. P., now University of Pittsburgh, engineering class of 1885, and from the time of his entrance into the affairs of the Leechburg Foundry & Machine Company has been an important figure in the industrial activities of Pittsburgh. In 1898 he organized the Mesta Machine Company and began construction of that well known organization at Mesta. The Mesta plant performed wonderful work during the great war. At a time when steel plate was absolutely essential to the building of ships for transport, Mesta designed and built in record time the 110-in. plate mill — aptly named "the Liberty Mill," located almost within stone's throw of the machine company's works, for Homestead Steel Works of Carnegie Steel Company. Three other similar mills were built from these designs. At this great moment the demand for open-hearth ingots was enormous; to supplement the record capacity of Homestead's own 64 furnaces could supply, Mesta contributed very materially by turning a daily supply of ingots over to its neighbor; the net result was an increase in shell supplies.

Mesta Machine has always been a leader in major engineering developments—their contribution to the science of the uniflow steam engine application being notable.

Mr. George Mesta was a member of the American Iron & Steel Institute, A. S. M. E., National Association of Manufacturers, Engineers Society of Western Pennsylvania; he was a member of the Duquesne Club, Country Club, University Club, Pittsburgh Athletic Club, Oakmont Country Club, Engineers Club, Machinery Club and the Banker's Club, New York City; Congressional Country Club, Chevy Chase Club, and Pennsylvania Society of Washington, D. C.

G. A. Richardson of the Bethlehem Steel Corporation has been giving a series of lectures, illustrated

by moving pictures, on the processes of making steel from the ore to the finished product. He spoke in Portland, Ore., on April 20-21 and in Seattle, Wash., on April 23 and 24. He has also delivered the lecture in other large Pacific Coast cities.

C. S. Nugent, superintendent of the open-hearth department, Pittsburgh Steel Company, Monessen, Pa., since 1919, has resigned. His successor has not yet been named.

Francis B. Foley, Lucey Manufacturing Corporation, Chattanooga, Tenn.; Zay Jeffries, Aluminum Company of America, Cleveland; Carl A. Meissner, United States Steel Corporation, New York; Earle C. Smith, Central Steel Company, Massillon, Ohio; Ewart S. Taylerson, American Sheet & Tin Plate Co., Pittsburgh, and C. W. Weesner, Trumbull Steel Company, Warren, Ohio, are among the candidates for membership in the Iron and Steel Institute, whose names appear on the voting list for the annual meeting in London, May 7 and 8.

Open Hearth Committee Organizes

A general committee composed of W. A. Maxwell, general manager, Inland Steel Company, Chicago, formerly superintendent of open hearth, Homestead Steel Works; A. R. Maxwell, assistant to president, Pittsburgh Steel Company, Monessen, Pa., formerly assistant superintendent Open Hearth No. 3, Homestead Steel Works; L. F. Reinarts, Superintendent Open Hearth, American Rolling Mill Company, Middletown, Ohio; E. A. Whitworth, general superintendent, Bourne-Fuler Company, Cleveland, Ohio; A. W. Smith, superintendent open hearth, Youngstown Sheet & Tube Company, and L. B. Lindemuth of Carney & Lindemuth, New York City, were chosen to organize the activities of an independent open hearth general co-operative movement, initiated under the auspices of the Institute of Mining and Metallurgical Engineers at Pittsburgh. From the character of the original technical papers rendered and discussed, the inception of this organization will fill an open field.

Some Pointers on By-Product Coke Oven Operations

The U. G. I. Contracting Company has received contract from the Tampa (Fla.) Gas Company to furnish and install a U. G. I. Vertical Waste Heat Boiler 5 ft. 7 in. in diameter. This is another evidence of the success of this boiler, inasmuch as the Tampa company already has U. G. I. waste heat boilers installed in its plant, which have given complete satisfaction for a number of years.

The Public Service Electric & Gas Company is preparing to add to the tar extractor equipment at its Newark plant, and has placed an order with the U. G. I. Contracting Company, of Philadelphia, for one U. G. I. Tar Extractor having daily capacity of 6,000,000 cu. ft.

G. V. Sborigi, chief engineer of the A. M. Byers Company has resigned, his duties now being delegated to O. M. Tishlarick, assistant chief engineer.

The Linde Air Products Company, New York, country-wide manufacturer and distributor of oxygen for welding and cutting, has recently opened the following new district offices:

716 First National Soo Line Building, Minneapolis, Minn., C. E. Donegan, district sales manager.

409 Lincoln Life Building, Birmingham, Ala., W. A. Kopp, district sales manager.

508 Exchange National Bank Building, Tulsa, Okla., G. D. Grubb, district sales manager.

Local oxygen sales activity and the extension of Linde Process Service for Linde oxygen customers, as well as the sale of Prest-O-Lite dissolved acetylene will be handled by these offices for their respective territories.

The Linde Company also announces the appointment of J. W. Foster as district sales manager at Baltimore. Prior to this appointment, Mr. Foster was a senior salesman in the Pittsburgh Linde district.

The popularity of the Chrisman Down Run Process is becoming increasingly evident and latest information comes to us that the Connecticut Light & Power Company has placed orders with The U. G. I. Contracting Company, of Philadelphia, for the installation of this process on two of its water gas sets at Norwalk.

The U. G. I. Contracting Company, of Philadelphia, has been awarded a contract by the Illinois Power & Light Corporation, for the installation of additional equipment at the plant in Centralia, Ill. The equipment to be installed will include a cone top carburetted water gas apparatus, having capacity of 1,230 M. cu. ft. per day. The apparatus will be equipped with back run connection and will be hydraulically operated. Likewise, it will be equipped with the U. G. I. process for the use of soft coal.

A New Rustless Steel Introduced in Sheffield

By A. C. Blackall

Thos. Firth & Company, Ltd., of Sheffield, one of the pioneers in the manufacture of stainless and rustless irons and steels, have recently introduced an improved stainless steel under the name of "Stay-brite." Whereas the previous types developed by this concern depended in part for their outstanding claims on strength and their fairly ready submission to the hardening process, the new type is not intended to be hardened. On the contrary, it is so malleable that it readily submits to being cold-pressed, thus opening up a wide field for its use.

This new type of steel will tend to supplant "stainless iron." In the original type the percentage of carbon produced the difference in the qualities, "stainless iron" having about one-third the carbon content generally associated with stainless steel. While this characteristic is retained in the new type, the metallurgist has discovered that malleability is secured by alloying a considerable percentage of nickel with a rich content of chromium, which also provides the stainless or rustless quality. So far as constituents are concerned, it will be seen that nothing new is employed, nickel in large and small quantities having been added to standard rustless steels and iron for some considerable period, and also to rustless steel and irons of high chromium content. It would seem, therefore, that the improved properties claimed for it are brought out by special treatment.

The makers prefer to use the word "rustless" rather than "stainless" in describing this new product, claiming the latter word to be in reality a misnomer. It is stated that the material is unaffected by the acids which usually find the weak spots—tartaric, formic, citric, and lactic acids, as well as phosphoric acid in all its strengths. It can be turned, milled, planed, and welded by the electrical processes, while soldering, brazing, and tinning processes are readily accomplished.

The makers are prepared to supply the new steel at prices which indicate that a solution is being found to the problem of making the cost of rustless materials less prohibitive. Table ware and kitchen utensils, automobile bonnets, watch-cases, brewery fittings, surgical appliances, and the like can be made of it, while in engineering valve rings and seatings and chemical plant are some of the suggested articles where immunity from corrosion will undoubtedly prove of advantage.

A possible disadvantage of this material lies in the fact that it is austenitic and consequently somewhat difficult and costly to machine. In this connection it is interesting to revert to the properties of the new "weatherproof iron," previously described. This material is softer than ordinary "rustless iron" and therefore easier to press and machine. In addition it is rustless without being polished.

NEWS OF THE PLANTS

The Mystic Iron Works, Inc., Boston, Mass., is pushing construction on its new blast furnace at Everett, Mass., and purposes to have the unit ready for service at the earliest possible date. It will comprise a number of operating buildings and auxiliary structures, estimated to cost in excess of \$1,000,000, with equipment. Contracts are being awarded for certain apparatus and other orders will be placed in the near future. The Cleveland Crane & Engineering Company will furnish a 55-ton ladle crane, while the C. O. Bartlett & Snow Company has secured an award for a skip hoist and conveyor to handle coal for the power house at the works.

The Sellers Manufacturing Company, 4651 Pensacola Street, Chicago, Ill., manufacturer of splice bars and kindred products, has completed plans and will soon begin the construction of a new rolling mill. It will be one-story, 85 x 165 ft., brick and steel, estimated to cost close to \$70,000. A general contract for the structure has been awarded to the McClintic-Marshall Company, South Dearborn Street, Chicago. J. M. Sellers is president.

The Pittsburgh-Des Moines Steel Company, Eleventh and Tuttle Streets, Des Moines, Iowa, manufacturer of steel plate products, has completed plans and will commence the erection of a new addition at its local mills. It will be one-story, 65 x 325 ft., estimated to cost approximately \$40,000. A list of equipment to be installed will soon be arranged.

The Ford Motor Company, Highland Park, Detroit, Mich., will soon proceed with the erection of a new open-hearth unit at its River Rouge Works, to be one-story, 106-245 ft., estimated to cost in excess of \$250,000, with machinery. It will be equipped and placed in service at the earliest possible date. Albert Kahn, Inc., Marquette Building, Detroit, is architect.

The Dennison Alloy & Steel Casting Company, Dennison, Ohio, recently organized with a capital of \$150,000, to manufacture alloy steel rolls and kindred products, has acquired a local mill formerly occupied by the Dennison Foundry & Machine Company, and will remodel and improve for a new plant. The structure is one-story, 185 x 300 ft., and will be equipped to give employment to about 200 operatives. It is planned to have the mill ready for service during June. William McNutt and S. C. Williams, both of East Liverpool, Ohio, and Robert Maxwell, Dennison, head the new company.

The National Tube Company, Frick Building, Pittsburgh, Pa., has acquired a large tract of land adjoining its present plant at Elwood City, Pa., and will use the site at a later date, it is said, for a new finishing mill. No official announcement has as yet been made by the company regarding the proposed expansion.

The American Sheet & Tin Plate Company, New Philadelphia, Pa., is carrying out an expansion program at its local mills to provide for increased output in a number of departments. The work will include the erection of a new one-story power house, with 300-kw. generator, boilers and accessory equipment.

Briggs & Turivas, Inc., Chicago, Ill., has recently consummated arrangements for the acquisition of the bar iron mill of the Republic Iron & Steel Company at East Chicago, Ind., and will take over the property on May 1. It is said that the new owner plans the formation of a new subsidiary company to operate the plant and proposes to make a number of improvements, including equipment replacements, for increased efficiency in service. The present mill has a rated capacity of about 6,000 tons of rolled iron per month, with employment of 600 men. The entire purchase represents a stated investment of \$300,000, and includes a tract of more than 15 acres of land.

The Allegheny Steel Company, Breckenridge, near Pittsburgh, Pa., has had plans prepared and will award contracts at an early date for the erection of a new building at its plant, to be 75 x 95 ft., brick and steel, estimated to cost close to \$50,000, including equipment. A list of machinery to be installed will be arranged at an early date.

The Houston Structural Steel Company, Center and Yale Streets, Houston, Texas, has completed plans for extensive improvements in its plant, including the construction of a new steel fabricating unit, 60 x 100 ft., enlargement of main mill unit and the erection of a new crane runway shed, 80 x 328 ft. Considerable additional machinery will be installed, including electric traveling cranes and other material-handling equipment. The entire expansion is estimated to cost about \$100,000.

The Union Seamless Tube Company, Bellevue, Ohio, manufacturer of seamless steel tubing and kindred products, has preliminary plans under way for the rebuilding of the portion of its plant recently destroyed by fire with loss reported in excess of \$40,000, including equipment. The rebuilding is expected to cost close to a like amount.

The Indiana Coke & Gas Company, Terre Haute, Ind., is reported to have preliminary plans under advisement for the construction of a new battery of coke ovens, comprising 30 units, estimated to cost close to \$500,000. It is expected to proceed with the work during the latter part of the present year. Warren I. Blauvelt is president.

The Michigan Iron & Chemical Company, East Jordan, Mich., has plans under way for the rebuilding of the portion of its local plant recently destroyed by fire with loss estimated at close to \$75,000, including equipment. The reconstruction is expected to cost close to a like amount.

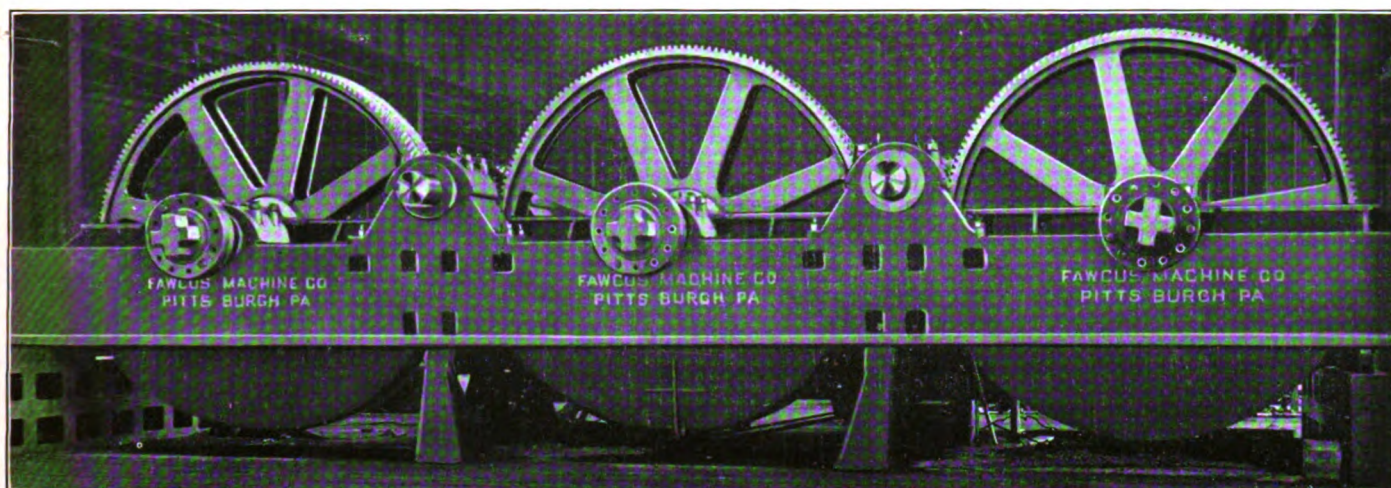
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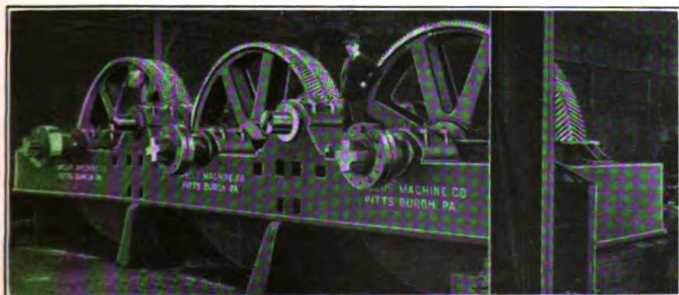


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